

bvj



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2 HAVO|VWO deel A

Biologie voor jou TTO

BIOLOGIE VOOR TWEETALIG ONDERWIJS

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Getting started with *Biologie voor jou TTO*

Biology is all around you. *Biologie voor jou TTO* puts all the tools within easy reach that you need for experiencing, enjoying and discovering it! The introductory chapter first tells you what biology is about, why the subject is important and what you can do with it.

BASICS
UNIT 1: PLANTS AND ANIMALS

1 Organisms

LEARNING OBJECTIVES

1.1.1 You can explain what an organism is.
1.1.2 You can list the seven life processes.
1.1.3 You can distinguish between things that are living, dead or non-living (never alive).

► Learning how to do research 1
► Practical activity 1

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES		
	1.1.1	1.1.2	1.1.3
Remembering	1a	2	
Understanding	1bc, 5	3, 5	4, 5
Using	10b	7a, 8, 10ac	6
Analysing		7bc, 9	7bc

The Greek word for life is *bios* and *logos* means a study or science. Together these two words make 'biology': the study of life.

LIVING CREATURES

Biology is about organisms. An **organism** is a living creature. Humans, animals and plants are organisms, just like bacteria and fungi are. All organisms have **life processes**. The life processes tell you whether something is **living** and therefore an organism. A stone does not have life processes, so a stone is not an organism.

You can see the life processes of an orang-utan in figure 1. The seven life processes are:

- breathing
- sensing
- growing
- feeding
- moving
- reproducing
- excreting

fig. 1 Life processes in an orang-utan.

Here were you last

§ 1.1 Living - dead - non-living
Flash cards

Continue

Content unit

§ 1.1 Living - dead - non-living

Progress paragraph

59%

Opdrachten

5/5

Test jezelf

0/2

Flitskaarten

2/5

Continue

§ 1.2 Making drawings

§ 1.3 Magnifying

EXTRA | IN DEPTH
UNIT 1: PLANTS AND ANIMALS

7 The importance of photosynthesis

LEARNING OBJECTIVE

1.7.16 You can explain that many fuels and raw materials exist thanks to photosynthesis.

TAXONOMY	LEARNING OBJECTIVE AND EXERCISES
Remembering	1.7.16
Understanding	1a
Using	1bcd, 2, 3
Analysing	

Plants can make glucose by photosynthesis. The plant can use glucose to make other substances. People depend on raw materials that were created thanks to photosynthesis.

FUELS

Natural gas, petroleum and coal are commonly used fuels. Petroleum is used to make petrol for cars. Many homes still have boilers that use natural gas. Coal is mainly used as fuel in power plants.

These fuels were formed from the remains of dead organisms that ended up on the sea bed millions of years ago. There they got compressed more and more by new layers of sand. The high pressure and heat changed the remains into coal, petroleum and natural gas. These are called **fossil fuels** (see figure 1). Fossil fuels originated from organisms that could live and grow thanks to photosynthesis.

fig. 1 Fossil fuels.

Back

1.6 Development

Flitskaarten

Last card

lifecycle

Turn over

Work in your book *and* work online!

There are two books for each school year plus an online learning environment. Your teacher will decide what you do online (with a laptop, tablet or phone) and what you do in your book.

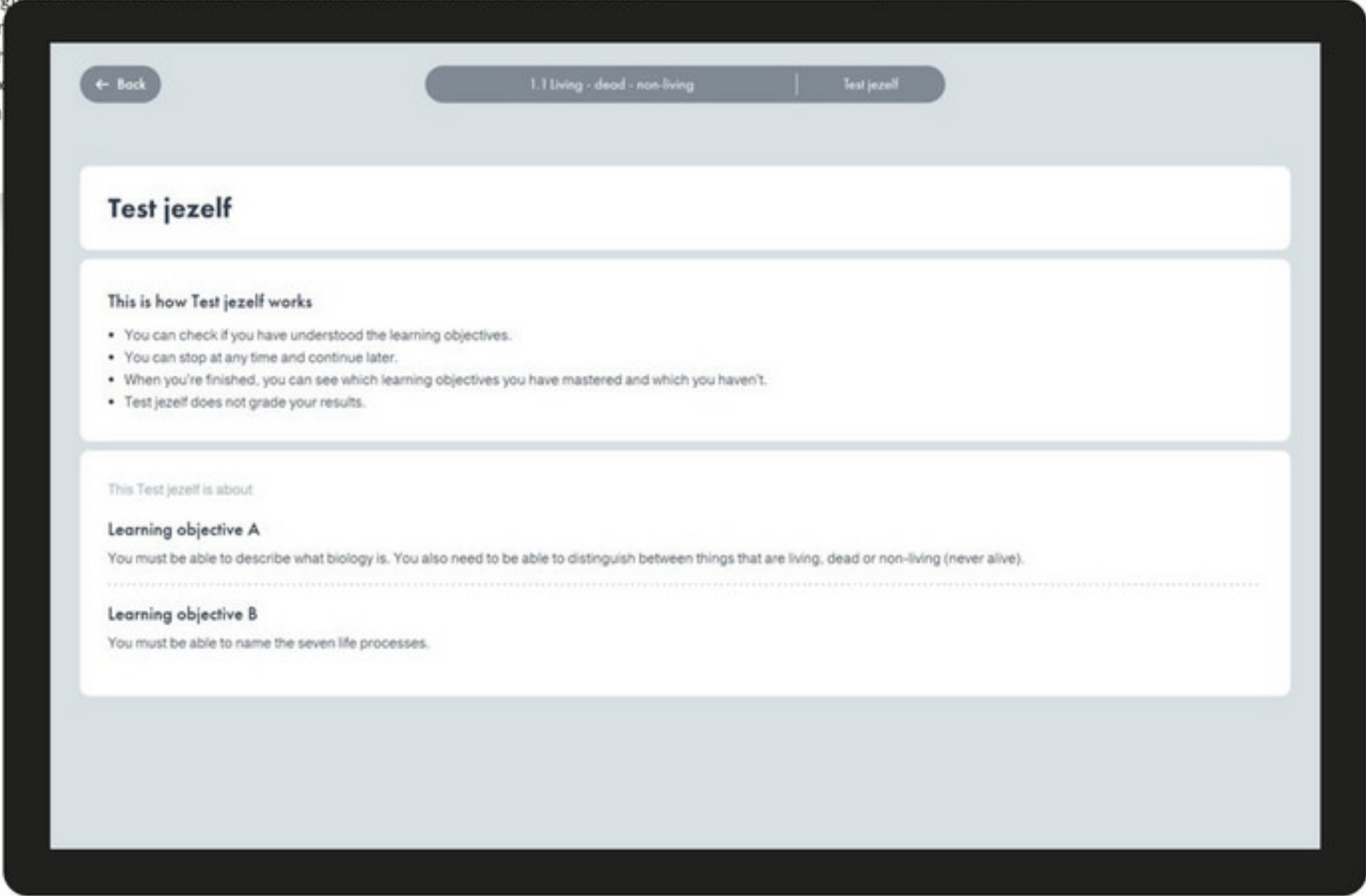
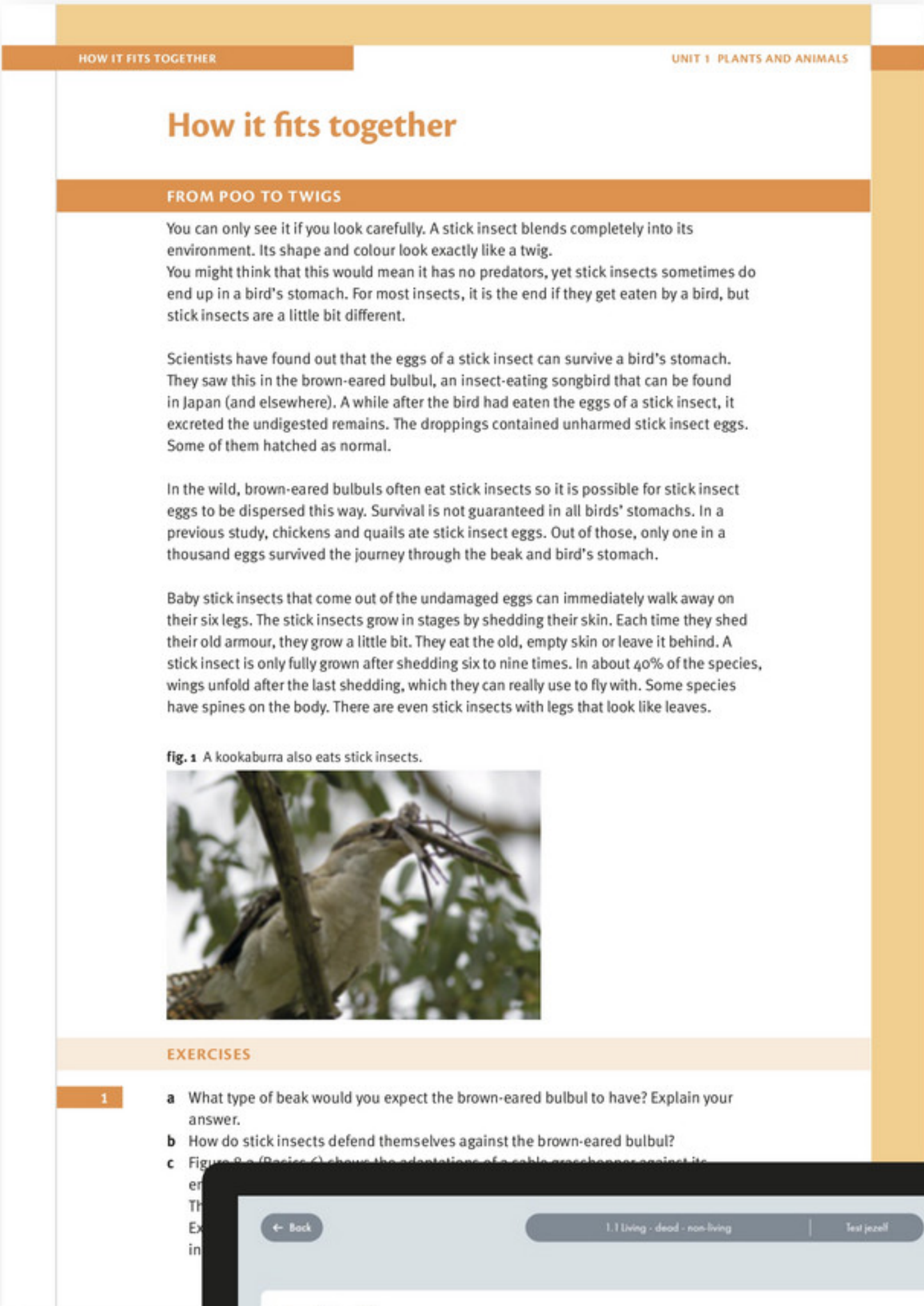
Each unit is split up into a Basics section, an Extra section, practical activities and a closing section. Learning objectives are always given at the start, telling you what you are going to learn and what level of taxonomy you will be using in the practical activities for the material you have learned. You can do the Extra sections if you want to know more or are feeling curious or have some spare time. In the activities section, you will do exercises and learn how to study and do research.

The advantages of working online

- You quickly see what you are doing correctly and what you are doing wrong.
- You get feedback on your answers straight away.
- You can watch video clips and animated clips.
- You learn the concepts and test yourself using the *Flash cards*.
- You can use the *Test yourself* sections, the practice test and the diagnostic test to see if you have understood the material.
- You can work at a higher or lower level or for a different school year.
- Your teacher will monitor how you are doing.

How it fits together

There is a section called *How it fits together* at the end of each Basics section and after all the Basics sections as a whole. These are in an orange frame. The way things fit together shows you why the course material is important in the world around you. You also learn to see connections between the information in the various Basics sections.

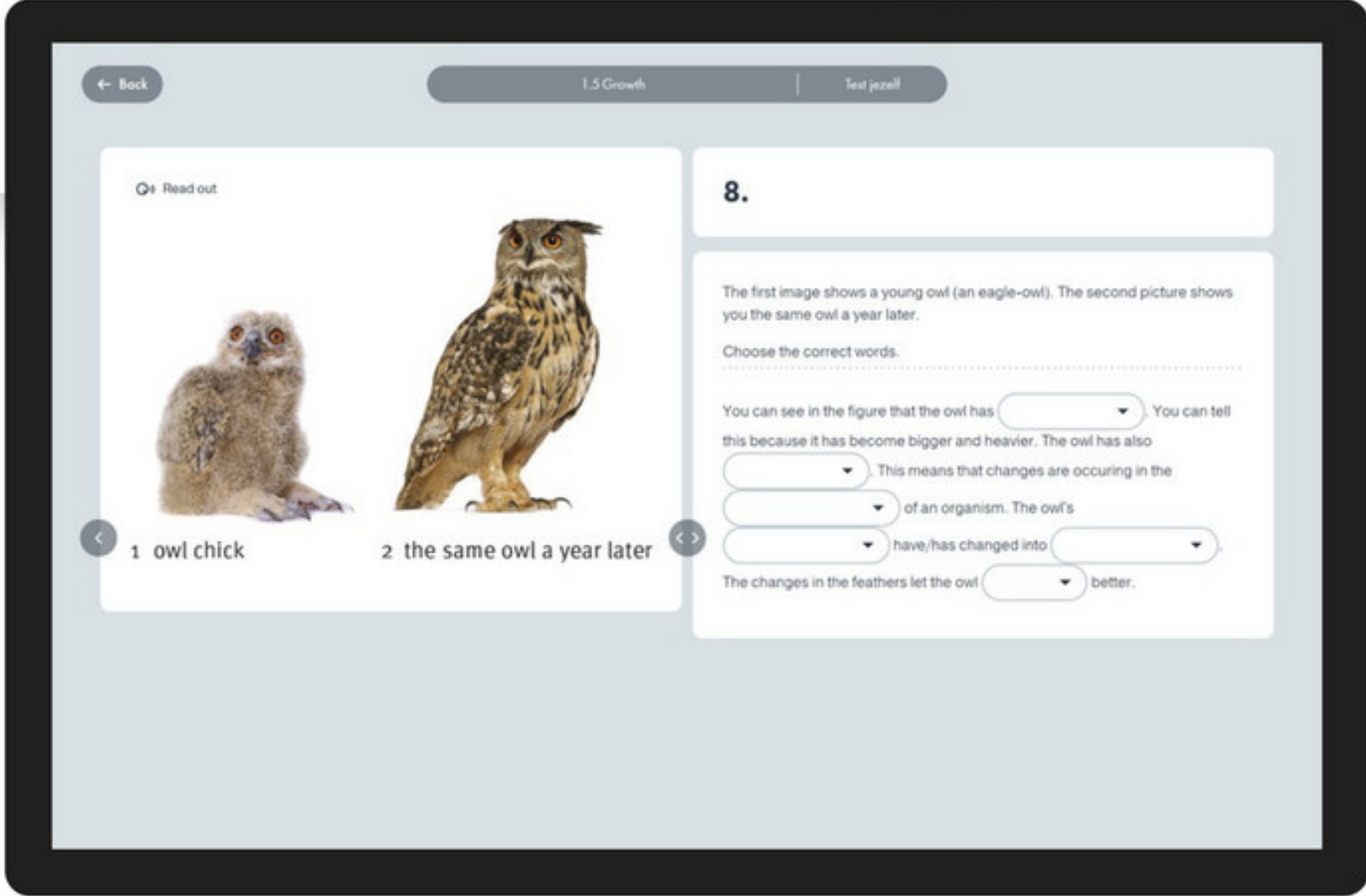
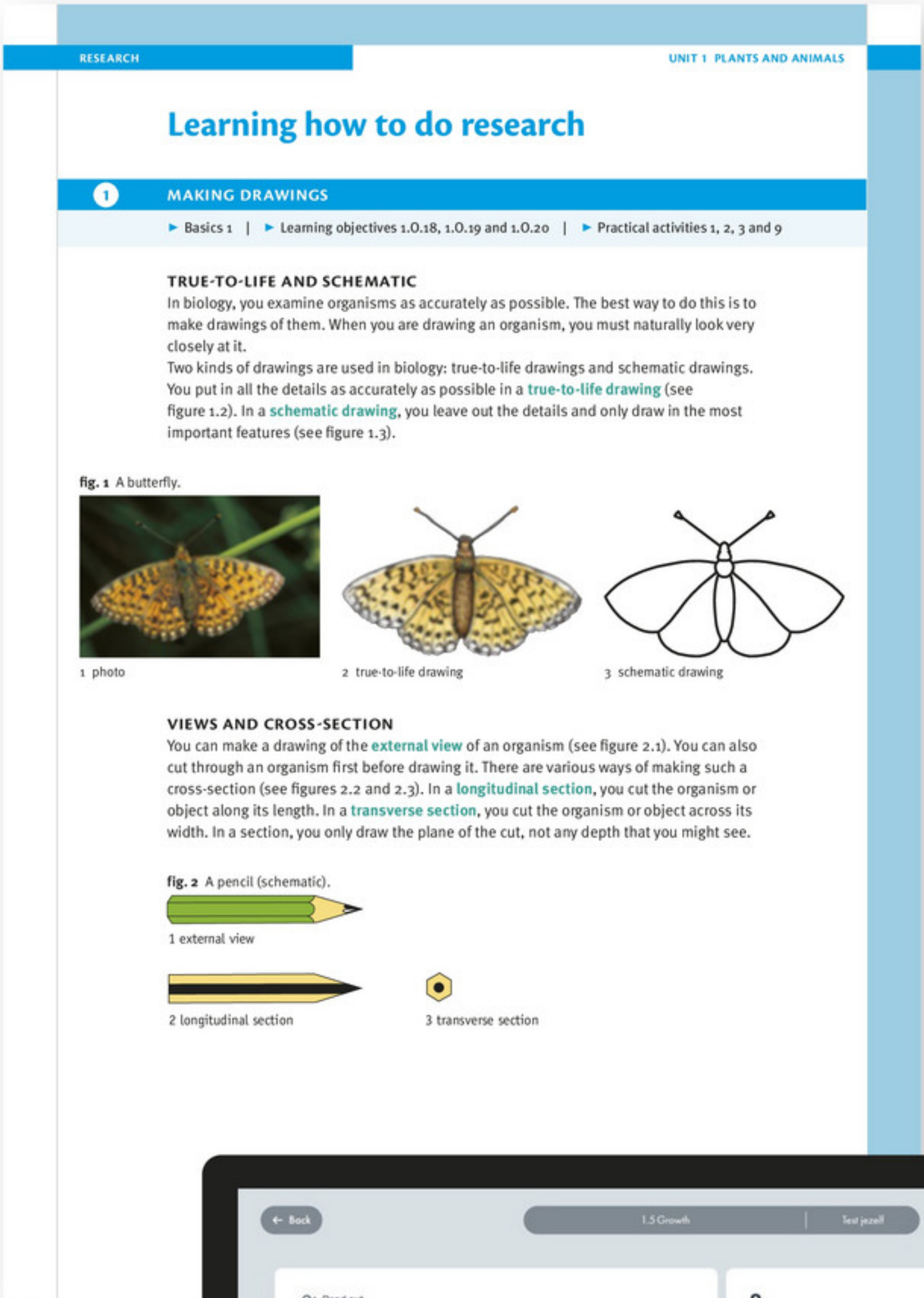


The advantages of the book

- You get a quick overview of what you will be learning.
- You can read the longer texts on paper.
- You can annotate the text and add remarks.
- You will be making drawings and adding colour yourself, which helps you remember things better.

Good preparation for the test!

The units end with a closing section (Summary). This is also where you can find the **Flash cards** for learning all the concepts. There is also a **Diagnostic test**. If you are not sure that you understand the material well enough, you can do the **Test yourself** section or the **Practice test**.



Meaning of the symbols

- This exercise is best done in your book.
- Go to the online learning environment for some useful extras.
- This is how long this practical activity will take.
- This exercise is extra challenging.

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Combustion and breathing

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How it fits together
*Looking good,
Good-looking!*

EXTRA

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RESEARCH

Learning how to do
research
Practical activities

TO FINISH

Summary
Diagnostic test



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- 6 DNA techniques
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*Tampering with genes
creates mirrored snails*

EXTRA

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RESEARCH

Learning how to do
research
Practical activities

TO FINISH

Summary
Diagnostic test



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- 3 Living together
- 4 Nature management
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environment
- 6 Sustainability
How it fits together
Elver smugglers caught

EXTRA

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- 8 Food production

RESEARCH

Learning how to do
research
Practical activities

TO FINISH

Summary
Diagnostic test



PROJECT

Caring for the future

Glossary
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1

Combustion and breathing

Your body burns fuel inside. That gives you energy for moving and keeping your body warm. Combustion needs oxygen. That gets into your body through your lungs.

BASICS

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8	Cold-blooded and warm-blooded	55

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1 Metabolism

LEARNING OBJECTIVES

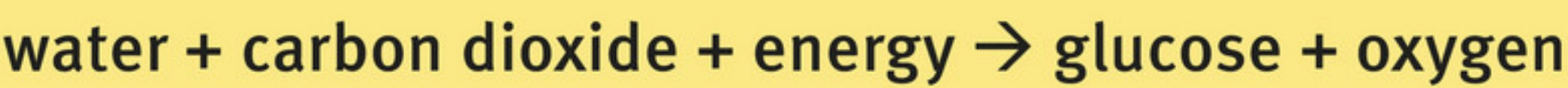
- 1.1.1 You can explain that plants use photosynthesis to store energy in the form of glucose.
- 1.1.2 You can explain that breaking down glucose releases energy.

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES	
	1.1.1	1.1.2
Remembering	1ab, 2	2
Understanding	1cd, 3ab, 4, 9ab	3b, 4
Using	6, 7, 9c	5, 6, 9d
Analysing	8, 9e	9e

Plants make food and oxygen for animals and people. The cells in your body use the substances that plants make. That gives you energy for moving and keeping warm.

PHOTOSYNTHESIS

When there is light, photosynthesis takes place in the green parts of plants. Chloroplasts use the energy of sunlight for converting carbon dioxide and water into **glucose** (see figures 1 and 2). Glucose contains a lot of energy. A plant uses that energy to make all sorts of other substances from glucose in turn, including the substances that the plant is made of. Photosynthesis also produces oxygen:



It's not only plant cells that can convert one substance into another. All organisms have a **metabolism**. Substances are constantly being converted inside the cells in your body as well. This lets you move and keep warm, as well as letting your body recover and grow. Metabolic processes are needed to stay alive.

fig. 1 Photosynthesis.

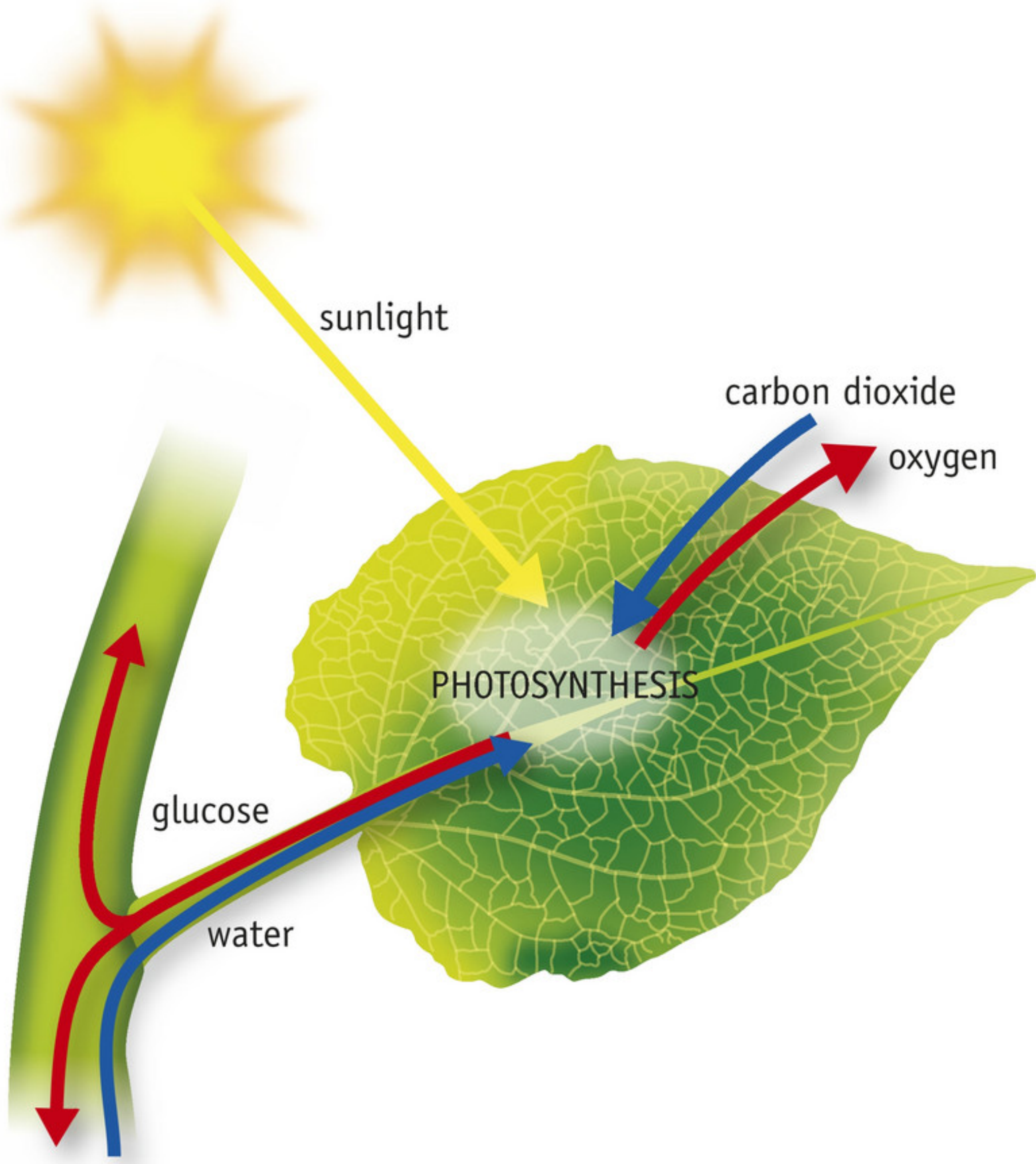
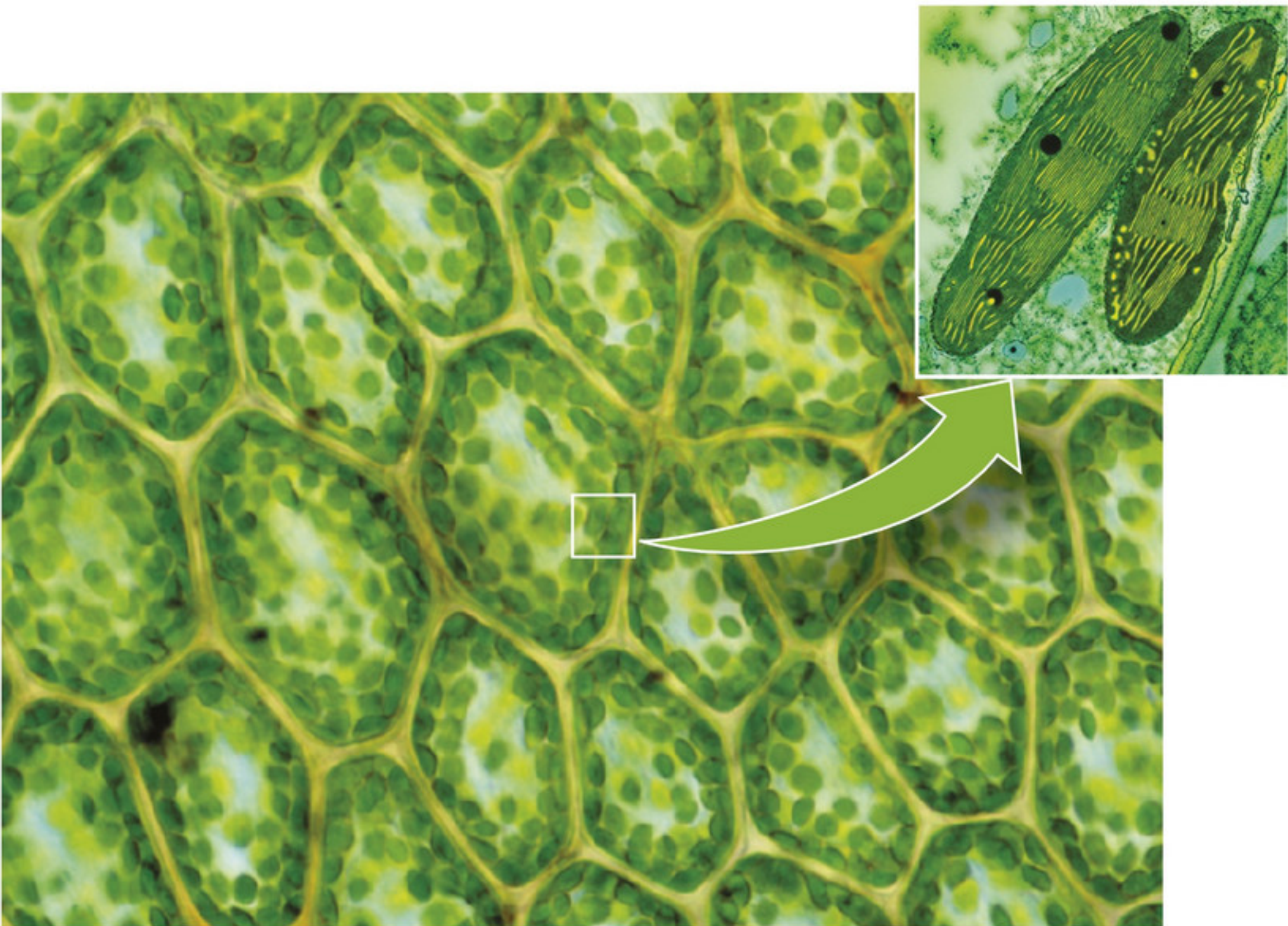


fig. 2 Chloroplasts in plant cells.



DECOMPOSITION

Chloroplasts store energy from sunlight in the form of glucose. The energy-rich glucose is then transported from the leaves to the other parts of the plant.

Cells use glucose as an energy source. Breaking down glucose releases the energy stored in it. The cell can use the energy and the breakdown products of glucose, for instance to make other new substances in turn. That lets the plant grow and make new parts. Glucose is also broken down in the cells of humans and other animals to release energy.

The breakdown of glucose happens in **mitochondria** (singular: mitochondrion). These are cell organelles that can be found in both plant and animal cells. You cannot see them with a light microscope, but they are visible in an electron microscope. In figure 3, the cell organelles have been coloured by computer so that you can see them more easily. The brown circles and rods in the cell in figure 3 are the mitochondria. Cells that need a lot of energy, such as muscle cells, have lots of mitochondria. The magnified image shows a single mitochondrion.

fig. 3 A cell and a mitochondrion.



KNOWLEDGE

1

a What substances does a plant need for photosynthesis?

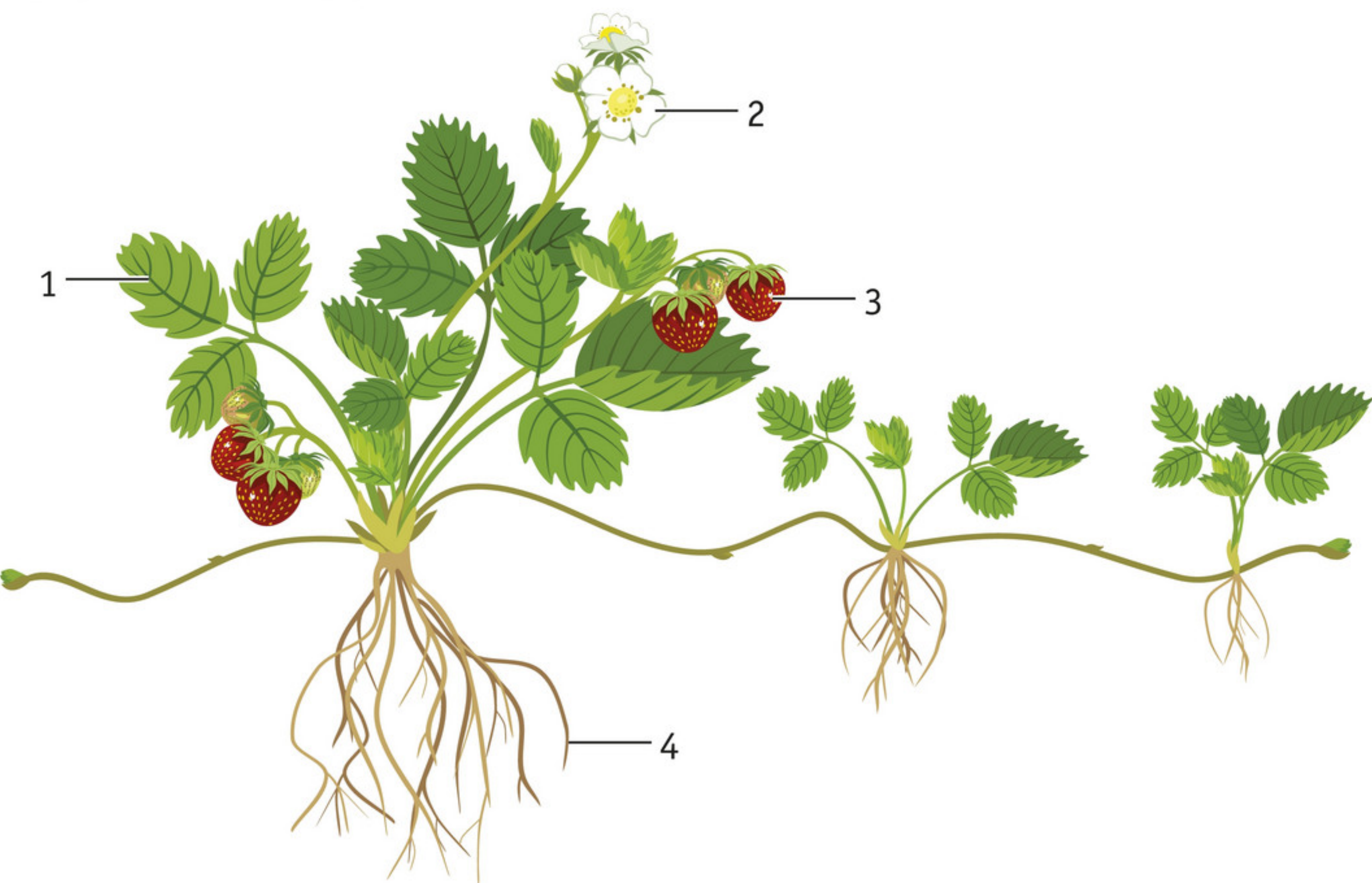
- ☐ A glucose
- ☐ B carbon dioxide
- ☐ C water
- ☐ D oxygen

b Which substances are produced by photosynthesis?

- ☐ A glucose
- ☐ B carbon dioxide
- ☐ C water
- ☐ D oxygen

- c** Figure 4 shows a strawberry plant.
Which parts of this plant can photosynthesis take place in?
In part 1 / 2 / 3 / 4
- d** The strawberry plant needs energy for photosynthesis.
Where does that energy come from?
- ☐ A the strawberries
 - ☐ B the chloroplasts
 - ☐ C the soil
 - ☐ D the water
 - ☐ E the sunlight

fig. 4 A strawberry plant.



2

What is metabolism?

3

- a** Chloroplasts can be found in *animal / human / plant* cells.
Mitochondria can be found in *animal / human / plant* cells.
- b** Glucose is *broken down / produced* in chloroplasts.
This process *stores / releases* energy.
Glucose is *broken down / produced* in mitochondria.
This process *stores / releases* energy.

4

Summary

Make a diagram showing how energy is stored and released in a plant cell.



INSIGHT

5

Muscles are made up of cells. Everyone's muscle cells are not the same: some people have muscle cells with lots of mitochondria and others have muscle cells with fewer mitochondria.

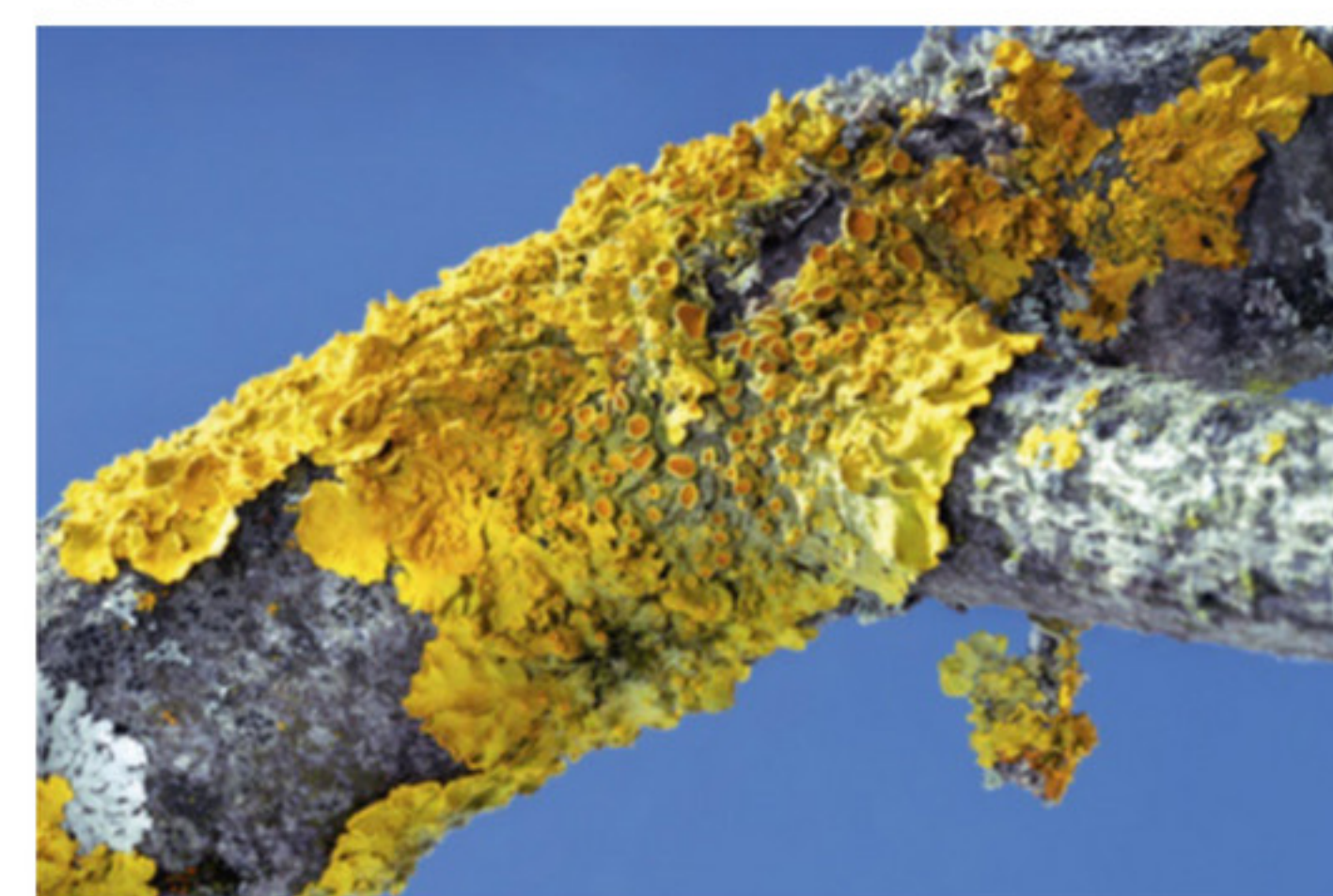
Explain which type of muscle cells you will mostly find in people who play sports a lot.

6

Figure 5 shows part of a tree. There are lichens living on the twig. A lichen consists of two types of organism: algae and a fungus. Algae are unicellular plants with chlorophyll but without a stem or roots. In a lichen, the algae are enclosed between two layers of mycelium. Photosynthesis takes place in lichens.

- The water for the photosynthesis is provided by the *algae / fungus / algae and the fungus*.
- The energy from sunlight is absorbed by the *algae / fungus / algae and the fungus*.
- Photosynthesis takes place in the *algae / fungus / algae and the fungus*.
- The glucose produced by the photosynthesis provides energy for the *algae / fungus / algae and the fungus*.

fig. 5 Lichen.



7

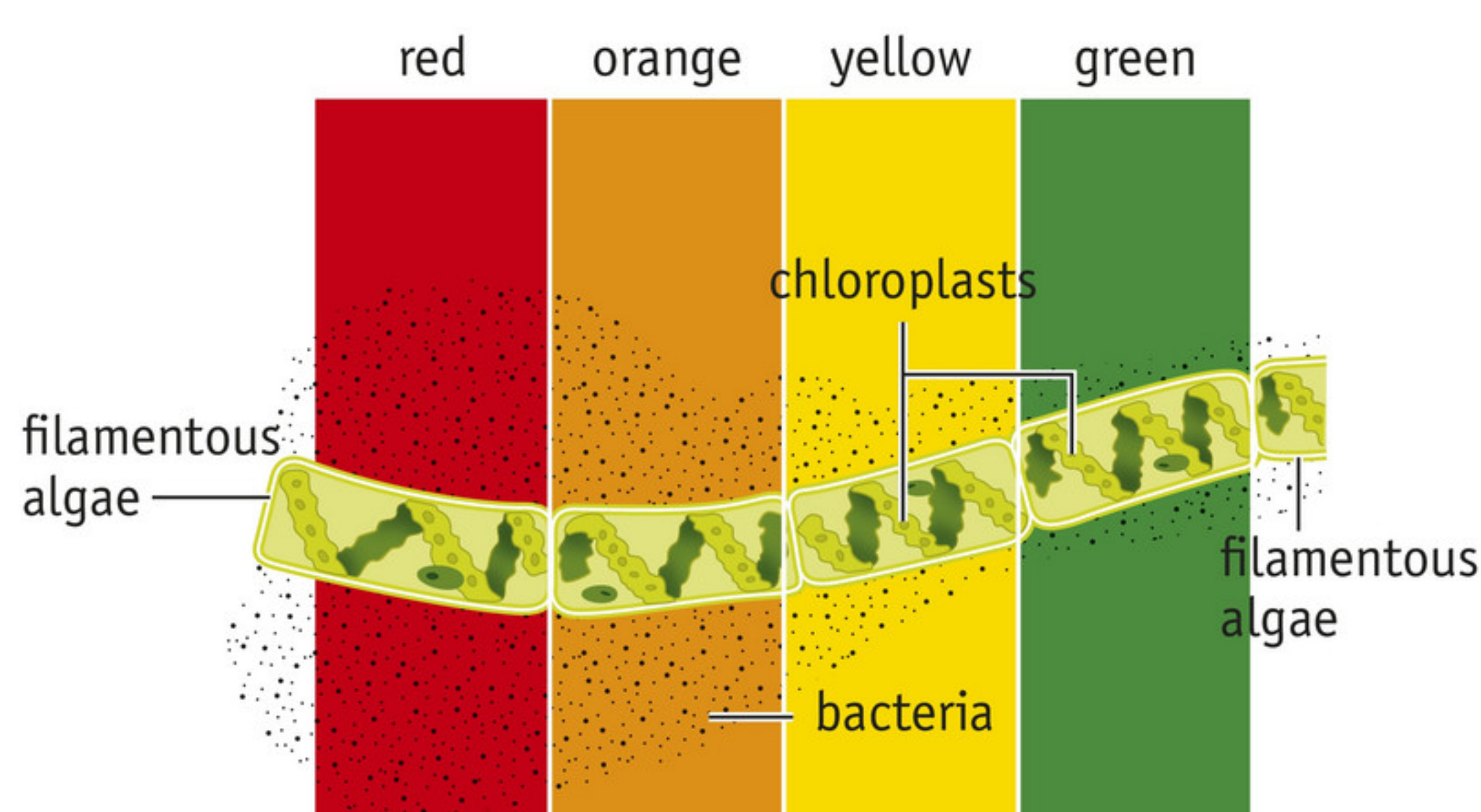
Debbie has an aquarium at home with fishes and waterweed (a water plant). She takes a plant out of the aquarium. She then puts the plant in a glass beaker of water (see figure 6). She puts a funnel over the plant. There is a test tube on the funnel that is completely filled with water. A bright light is shining down above the glass beaker. The plant produces bubbles of gas. After a few hours, this makes the water level in the test tube fall.

- What gas is it (mostly) in the test tube above the water? Explain your answer.
- Has the amount of carbon dioxide in the water beneath the funnel stayed the same, decreased or increased? Explain your answer.

fig. 6 Experiment with waterweed.



fig. 7 Filamentous algae.



+ 8

Filamentous algae are small, threadlike water plants. Figure 7 shows you a drawing of four pieces of such an alga. A different colour of light is shining onto each piece. There are bacteria living near the filamentous algae. You can also see those bacteria in the image.

What does figure 7 tell you about the influence of the colour of light on photosynthesis?

HOW IT FITS TOGETHER biology in professional life

BELL PEPPER CULTIVATION ADVISER

René advises growers in the horticulture sector (greenhouses). Many growers have high-tech companies and they like using new methods. René helps them with that. He specializes in bell pepper production. To keep his knowledge up to date, he works closely with a team of researchers.

René pays close attention to the lighting in the greenhouses. A modern greenhouse is covered with a special protective cloth that saves energy and protects the plants against light that is too bright. René advises his clients about special LED lighting that is placed between the plants rather than being hung above them. This means that the leaves at the bottom get light as well.

He also advises his clients about using different colours of light. The colour of the light affects the plants' growth. The lighting often remains on for part of the night.

The temperature inside the greenhouse is precisely controlled, often using computers. If necessary, extra carbon dioxide is pumped into the greenhouse too. That carbon dioxide is released by the combustion of natural gas in the heating system.

Vocational training courses in the agri-food sector pay a lot of attention to new techniques. As well as high yields, sustainability is important if a company is to be successful. René did a vocational course in Horticulture and Agribusiness.

fig. 8 René at work in a greenhouse.



9

Read the text 'Bell pepper cultivation adviser'.

The air in a greenhouse contains more carbon dioxide than the outside air.

- Explain why the grower adds carbon dioxide to the air in the greenhouse.
- A grower lights up his greenhouse for part of the night.
Explain why they do that.
- Why is it important that the bottom leaves of the plant get light too?
- Where do the peppers get the energy from that they need to grow?
- There is a pepper growing on a plant. Theresa eats the pepper and then goes on a bike ride.

Describe three metabolic processes that take place here. Also say which cell organelles the processes are taking place in.

 Go to the *Flash cards* and the *Test yourself* section.

2 Respiration and combustion

LEARNING OBJECTIVES

- 1.2.3 You can explain the relationship between respiration in cells and physical activity.

1.2.4 You know that respiration uses oxygen and creates carbon dioxide.
- Learning how to do research 1 and 2

► Practical activities 1, 2 and 3

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES	
	1.2.3	1.2.4
Remembering	2a	1a
Understanding	2bc, 4, 9ab	1bc, 3, 4
Using	6a, 7	5
Analysing	6b, 9cde	8

A petrol engine burns fuel (petrol) to release energy. In that combustion, the fuel disappears and other substances appear in its place. Combustion also takes place inside your body.

ENERGY

Glucose is broken down in your body to release energy. All the organs in your body need energy. For example, you need energy for moving and to keep your body temperature up (at roughly 37 °C).

fig. 1 All organisms need energy.



1 in order to move



2 to keep the body up to temperature

The breakdown of glucose in cells is a form of combustion, a metabolic process called **respiration**. The combustion that takes place inside your body does not need fire but it does need **fuel**. Cells use glucose as fuel. This combustion – respiration – takes place in every single cell of your body, day and night. Without respiration, a cell dies. That is not just true for human cells: it applies to every living cell in any organism.

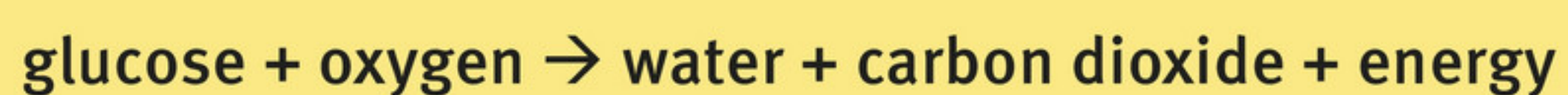
OXYGEN AND CARBON DIOXIDE

Combustion needs oxygen as well as fuel. Take a burning candle, for example: if you put a glass or beaker over a burning candle, it will go out (see figure 2). This is because the oxygen gets used up.

fig. 2 The candle will go out if there is not enough oxygen.



Your body's respiration is just the same: it needs a fuel (glucose) and oxygen. Combustion produces waste products, namely water and carbon dioxide. Oxygen is therefore needed for converting glucose into carbon dioxide and water (or water vapour). This releases energy:



The energy that is released is converted into movement and heat. The heat is then given off to the surroundings. When you are more active, you need more energy. The greater the physical effort, the more combustion takes place. Your heart and lungs are then working harder to make sure that the cells get enough fuel and oxygen and to get rid of the waste products, water and carbon dioxide.

KNOWLEDGE

1

The breakdown of glucose in cells is a form of combustion, a metabolic process called respiration.

a Fill in the missing words.

glucose + ... $\rightarrow$ + water + energy

b Which cell organelles does the combustion take place in?

c When does this combustion take place in plant cells?

- ☐ A never
- ☐ B only during the day
- ☐ C only at night
- ☐ D during the day and at night

2

a When does more respiration take place in your body cells?

- ☐ A When you are active.
- ☐ B When you have just eaten.
- ☐ C When you have just woken up.
- ☐ D When you are asleep.

b When is there more respiration taking place in your muscle cells: when you are playing sport or when you are sitting in class? Explain your answer.

c You feel cold.

How does your body respond to that: with more respiration or less?

3



Photosynthesis and respiration are two processes.
Complete the table.

	Photosynthesis	Respiration
Which organisms does the process take place in?		
Which cell organelles does the process take place in?		
Does the process take place in the light or in the dark or both?		
Is oxygen produced or consumed?		
Is carbon dioxide produced or consumed?		
Is glucose produced or consumed?		

4



Summary

- Say what respiration is and what substances are converted during it.
- Explain when and where respiration takes place.
- Explain when a lot of respiration takes place and what this means for the amounts of substances that are being converted.

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INSIGHT

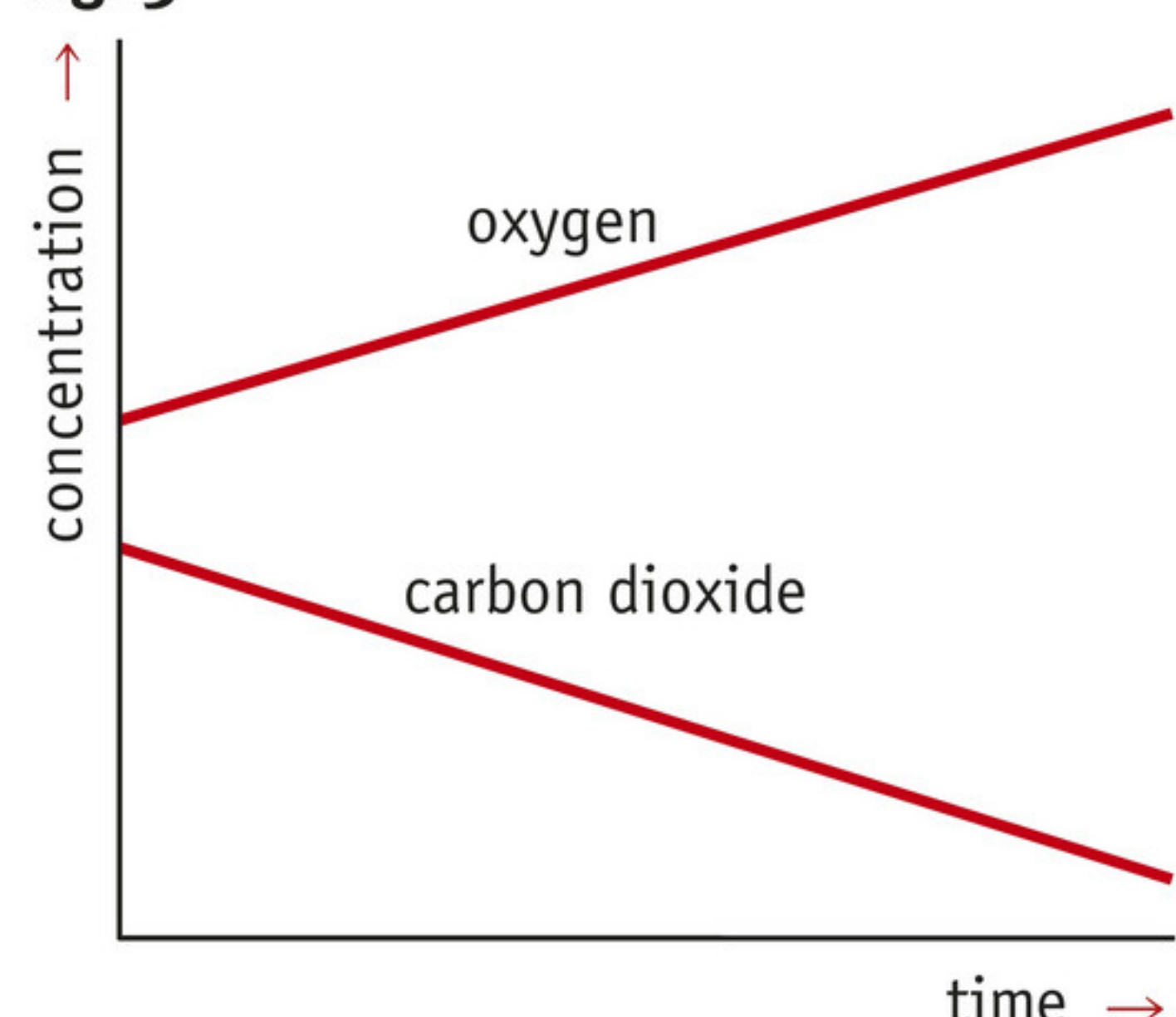
5

There are organisms in a space that has been closed off. All the organisms are of the same species. The diagram in figure 3 shows you how the amounts of oxygen and carbon dioxide in the room change.

Which statement about the organisms in the room is correct?

- ☐ A The space contains animals that live in the dark.
- ☐ B The space contains animals that live in the light.
- ☐ C The space contains plants that are in the dark.
- ☐ D The space contains plants that are in the light.

fig. 3



6

William runs marathons. He always trains outdoors, both in summer and in winter.

- a** When does his training need more energy: in the summer or in the winter? Explain your answer.
- b** In major physical exertion, less blood flows to most of the organs and more blood flows to the muscles. Explain why.

7

Changes take place in your body during physical exercise. One such change is mentioned in each of the following sentences.

Complete each of the sentences by explaining why that change is needed.

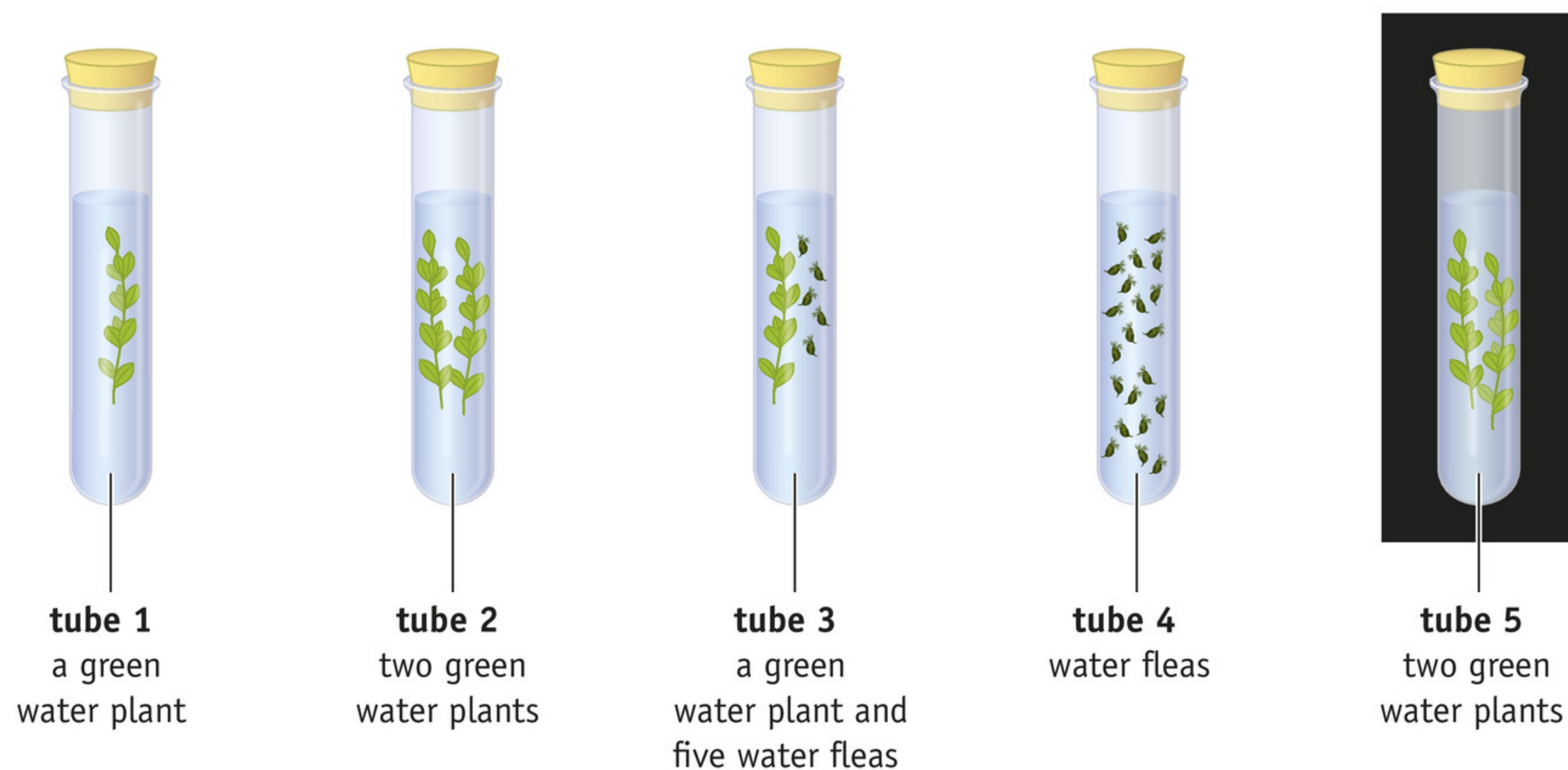
- 1 The breathing rate increases because
- 2 The heart starts beating more quickly because
- 3 You get hot because

+ 8

Figure 4 shows five different test tubes containing plants and/or animals. Only tube number 5 is in the dark; all the others are in the light.

- In which tube (or tubes) is glucose being produced?
in tube 1 / 2 / 3 / 4 / 5
- In which tube (or tubes) is glucose being consumed?
in tube 1 / 2 / 3 / 4 / 5
- After a few hours, which tube will contain the most oxygen?
in tube 1 / 2 / 3 / 4 / 5
- After a few hours, which tube will contain the least carbon dioxide?
in tube 1 / 2 / 3 / 4 / 5

fig. 4



HOW IT FITS TOGETHER the world we live in

SMALL ANIMALS WITH BIG APPETITES

You probably eat three times a day, with a snack in between occasionally. That is a normal eating pattern for humans. Things are different for animals. Many animals don't eat every day. Migratory birds often eat a great deal before starting their trek. A bar-tailed godwit's bodyweight, for instance, can double before it starts its migration. It eats very little during the migration. A tiger can eat forty kilograms of meat at one sitting. After a meal like that, it can go for two weeks without food.

There are also animals that do eat every day. A pygmy shrew eats four grams of food every day. That may not sound like a great deal, but it is roughly its own bodyweight. A blue whale, though, eats about four tons of krill every day. Krill is made up of tiny, shrimp-like sea creatures. A blue whale weighs up to about a hundred and fifty tons. So compared to its bodyweight, the blue whale eats less than a pygmy shrew. That is generally true for other animal species: large animals eat proportionately less than small animals.

fig. 5 A tiger can live for two weeks from a large prey animal.



9

Read the text 'Small animals with big appetites'.

A rabbit is much smaller than a human. An average human weighs 70 kg but an average rabbit weighs 2 kg. The body surface area (BSA) of a human averages about 1.8 m², whereas that of a rabbit averages 0.186 m².

- a** What is the total BSA of 35 rabbits? m²
- b** How much bigger is the body surface area of 35 rabbits than that of a single human? Round your answer off to one decimal place.

The body surface area of 35 rabbits is × the BSA of a single human.

- c** The cellular respiration processes in a rabbit's body go much more quickly than in a human body. Explain why.
- d** Explain why smaller animals have to eat more per kilogram bodyweight than larger ones do.
- e** Humans eat three or four times a day.
What eating pattern would you expect wild rabbits to have?

 Go to the *Flash cards* and the *Test yourself* section.

3 The respiratory system

LEARNING OBJECTIVE

1.3.5 You can name parts of the respiratory system with their features and functions.

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES	
	1.3.5	1.2.4*
Remembering	1	
Understanding	2, 3, 4, 5, 10a	
Using	6, 7, 8, 9a, 10bcd	
Analysing	9b	10e

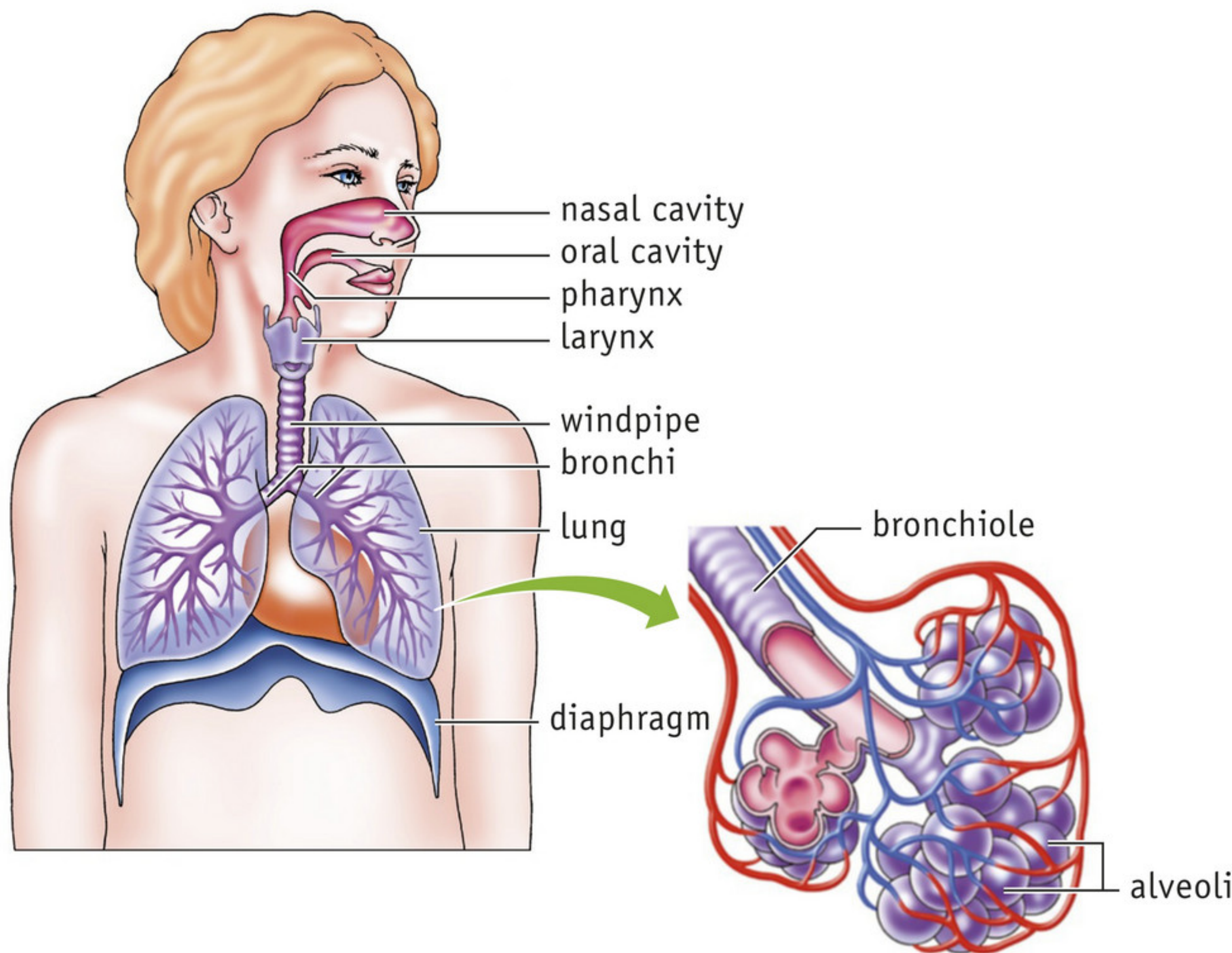
* You can find this learning objective in another Basics section.

Your body needs oxygen for the combustion of fuels. You get oxygen from the air through your lungs. Your nose and your diaphragm are part of the respiratory system too.

RESPIRATORY SYSTEM

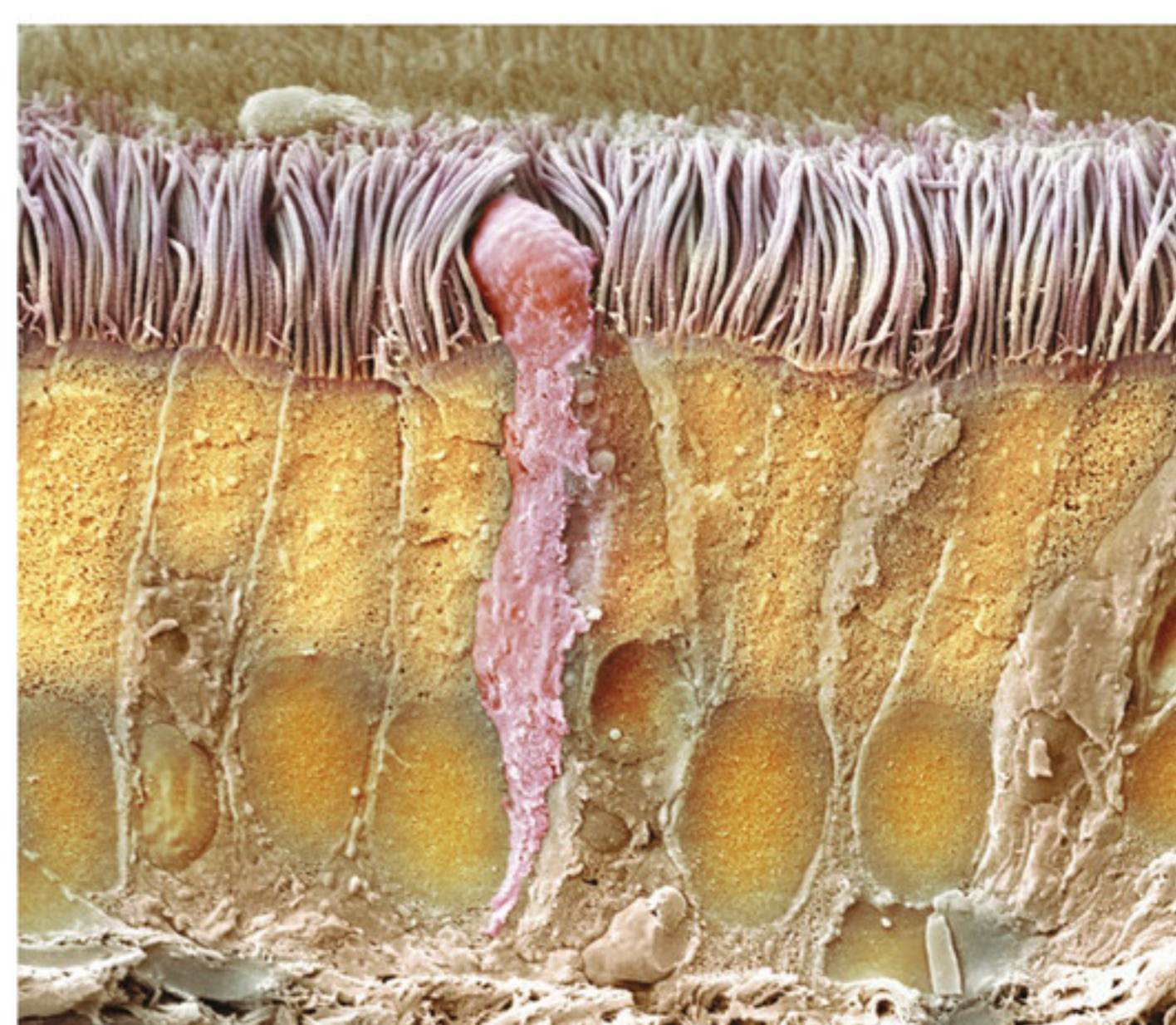
Figure 1 is a diagram of the human respiratory system. When you breathe in, air comes in through the nasal cavity or oral cavity into the throat (pharynx). The air then flows past the voice box (larynx) into the windpipe (trachea). The windpipe then splits into two **bronchi**, which in turn split into smaller and smaller tubes called bronchioles. At the ends of the bronchioles, there are bundles of air sacs called alveoli. The diaphragm is below the lungs. The **diaphragm** is a tough, muscular membrane that separates the thoracic cavity (chest cavity) from the abdominal cavity. The diaphragm can move up and down.

fig. 1 The human respiratory system (diagram).

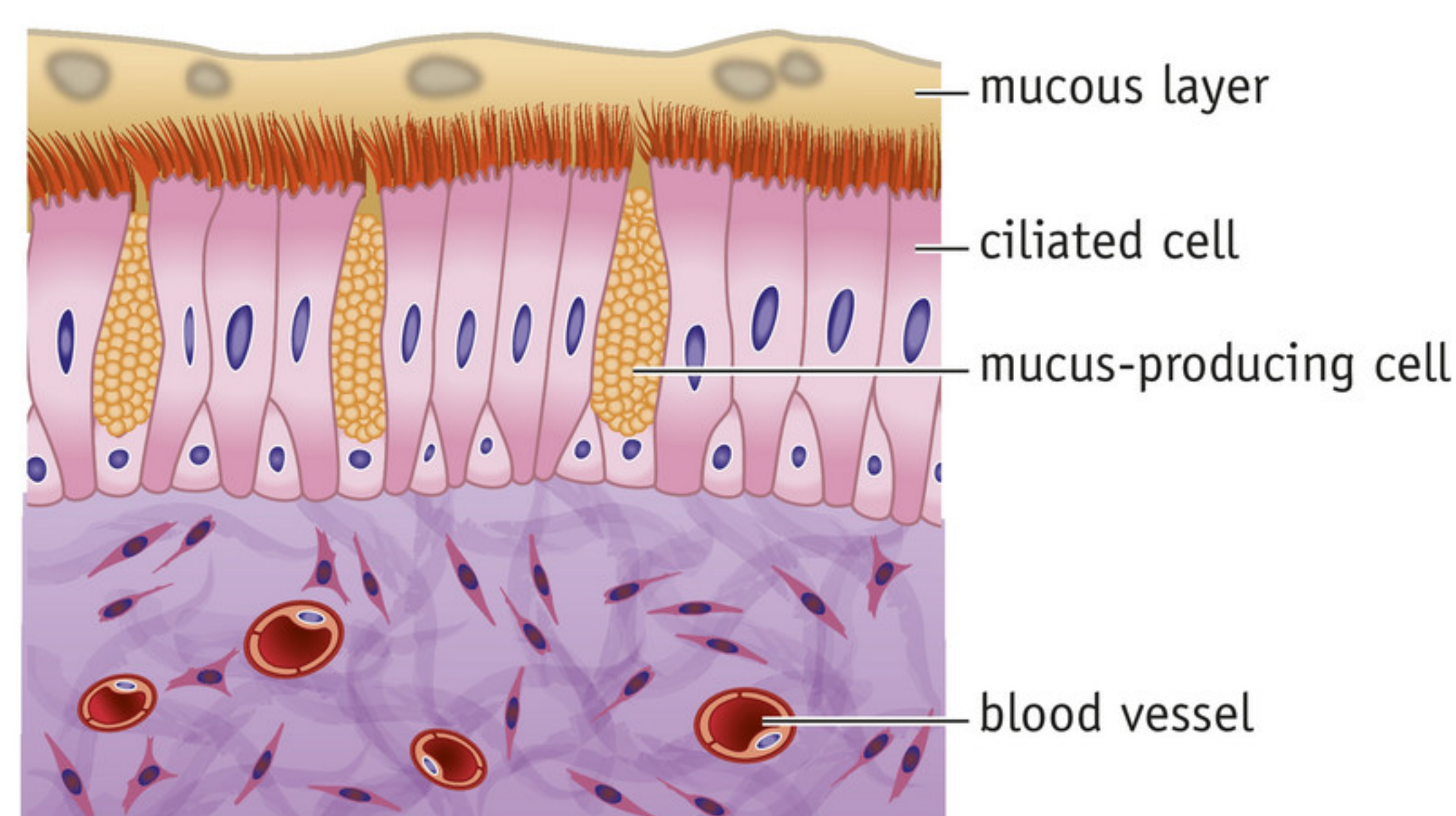


NASAL CAVITY AND ORAL CAVITY

Most people breathe through their noses. The nasal cavity is covered with the **nasal lining**, which is made up of mucus-producing cells (see figure 2). The mucus means that the nasal cavity is moist so that the inhaled air also gets moistened. There are also lots of small blood vessels just under the surface of the nasal lining. The blood keeps the nasal lining warm and therefore helps warm up the incoming air.

fig. 2 Nasal lining.

1 electron microscope photo (SEM, 1500× magnification)



2 drawing

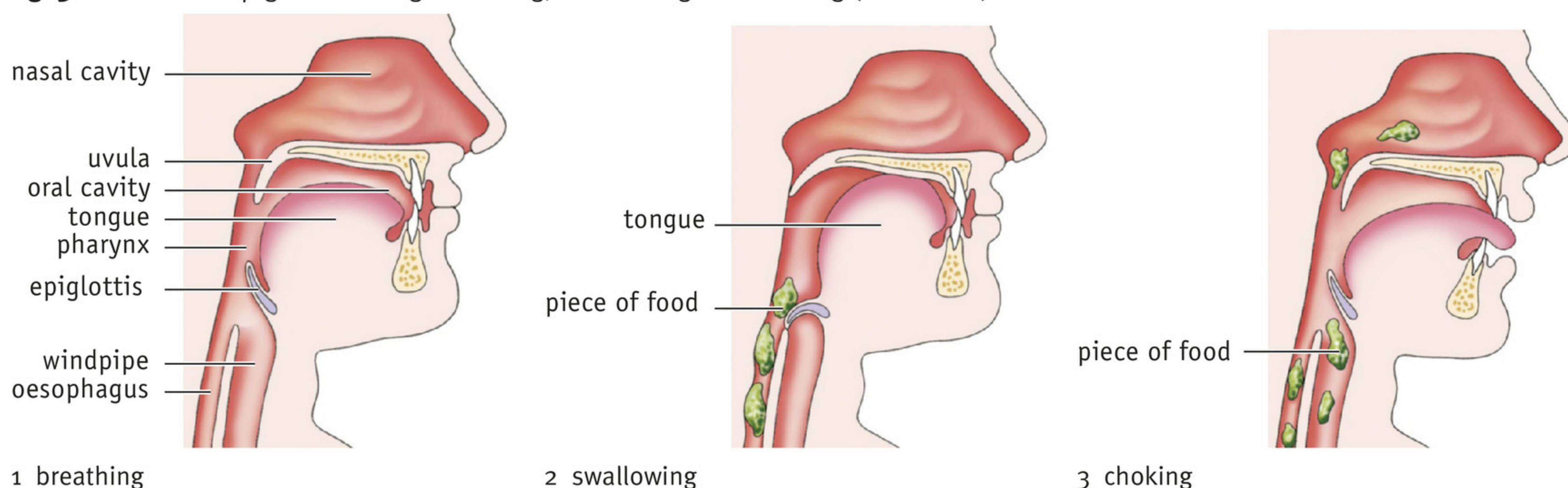
The air that you breathe in often contains dust particles and germs. In the front part of the nasal cavity, there are nasal hairs that trap any larger dust particles. Smaller dust particles and germs stick to the nasal lining. Small hairs called **cilia** sweep the mucus along with the dust particles towards the back of the pharynx where it is then swallowed.

The sense of smell – the olfactory system – is located in the roof of the nasal cavity. It checks the incoming air and warns you if it contains smelly gases, for example. When you breathe in through your mouth, the inhaled air is cleaned, warmed and moistened less. As a result, the mucous membranes in the lungs can get damaged. You are less able to smell things when breathing through the mouth too. Breathing through the nose is therefore healthier than breathing through the mouth.

PHARYNX

After the nasal cavity or oral cavity, the air passes through the pharynx and goes into the windpipe (trachea). Inhaled air is however not the only thing that goes through the pharynx: the food you swallow has to go through it too. The **epiglottis** makes sure that food cannot get into your windpipe. When you are breathing, both the oesophagus and the windpipe are open (see figure 3.1). The air can then flow from your nasal cavity into your lungs through the windpipe and back out again. When you swallow food, the **uvula** closes off the nasal cavity and the epiglottis closes off the windpipe (see figure 3.2). The food is then able to get from the oral cavity into the gullet (oesophagus), but will not end up in the nasal cavity or trachea.

Sometimes the epiglottis and the uvula may not work completely, for instance if you are laughing. This can make you choke – in other words, food or drink can slip into the windpipe or get into the nasal cavity (see figure 3.3). Coughing then removes the food particles from the windpipe again.

fig. 3 Uvula and epiglottis during breathing, swallowing and choking (schematic).

TRACHEA AND LUNGS

The **windpipe** or **trachea** is a hollow tube that is connected to the lower end of the larynx. The wall of the windpipe has horseshoe-shaped rings of cartilage around it to make sure it is always open and cannot collapse (see figure 4). The walls of the bronchi also have cartilage rings. The walls of the smallest bronchioles have small muscles rather than cartilage rings.

The walls of the windpipe, bronchi, bronchioles and alveoli are covered with a mucous lining. Cilia are continuously sweeping the mucus towards the pharynx where it is swallowed.

At the ends of the bronchioles, there are bundles of air sacs called **alveoli**. The surface area of all your alveoli taken together is 70 to 100 m², about as big as one and a half classrooms. The alveoli are surrounded by a network of small blood vessels known as the **pulmonary capillaries** or **lung capillaries** (see figure 5). The walls of pulmonary capillaries and alveoli are extremely thin – so thin that oxygen and carbon dioxide can pass through them. In the drawing, blood with a low oxygen level is shown in blue and blood with lots of oxygen is shown in red.

fig. 4 The windpipe and part of the oesophagus.

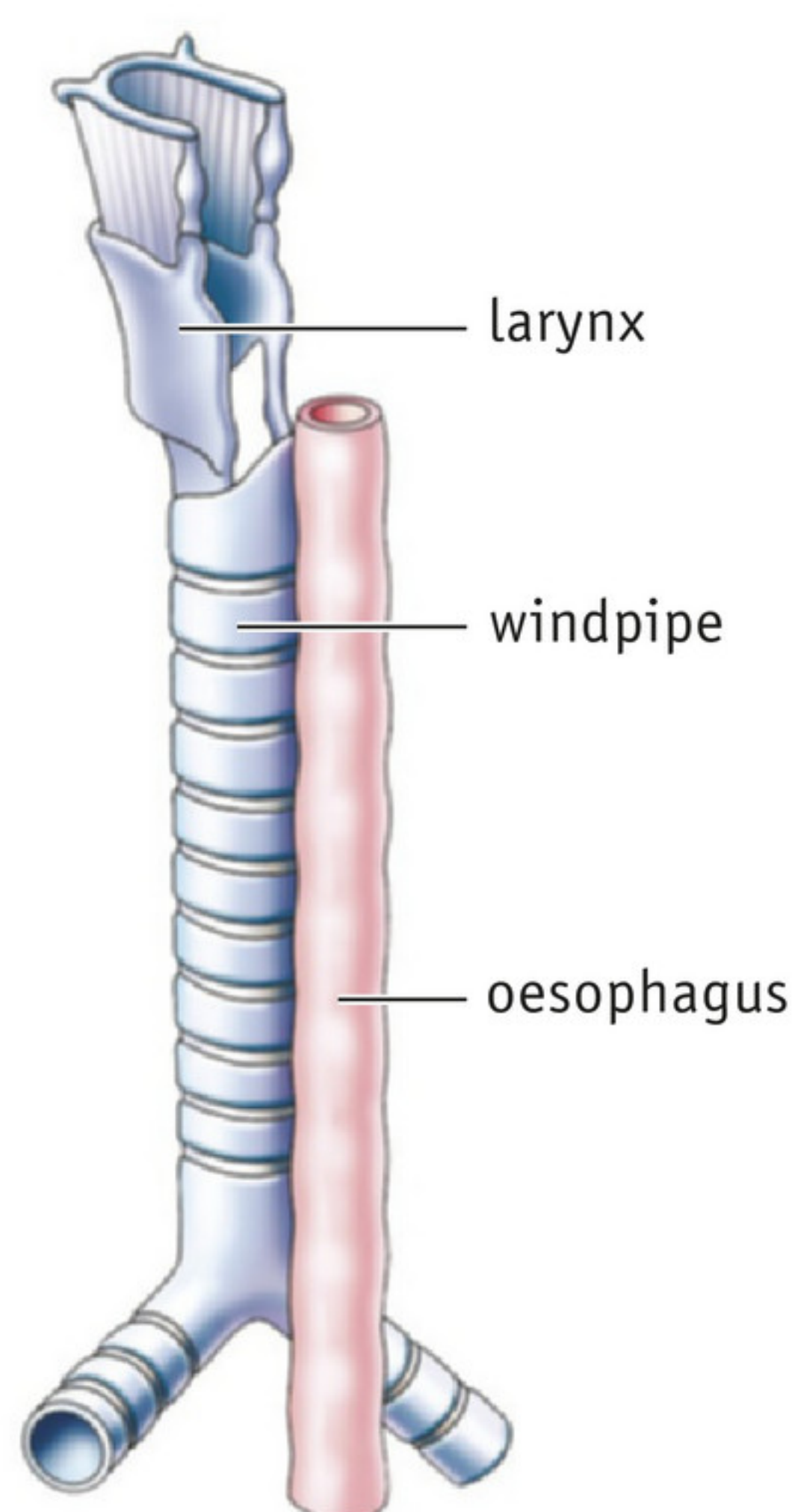
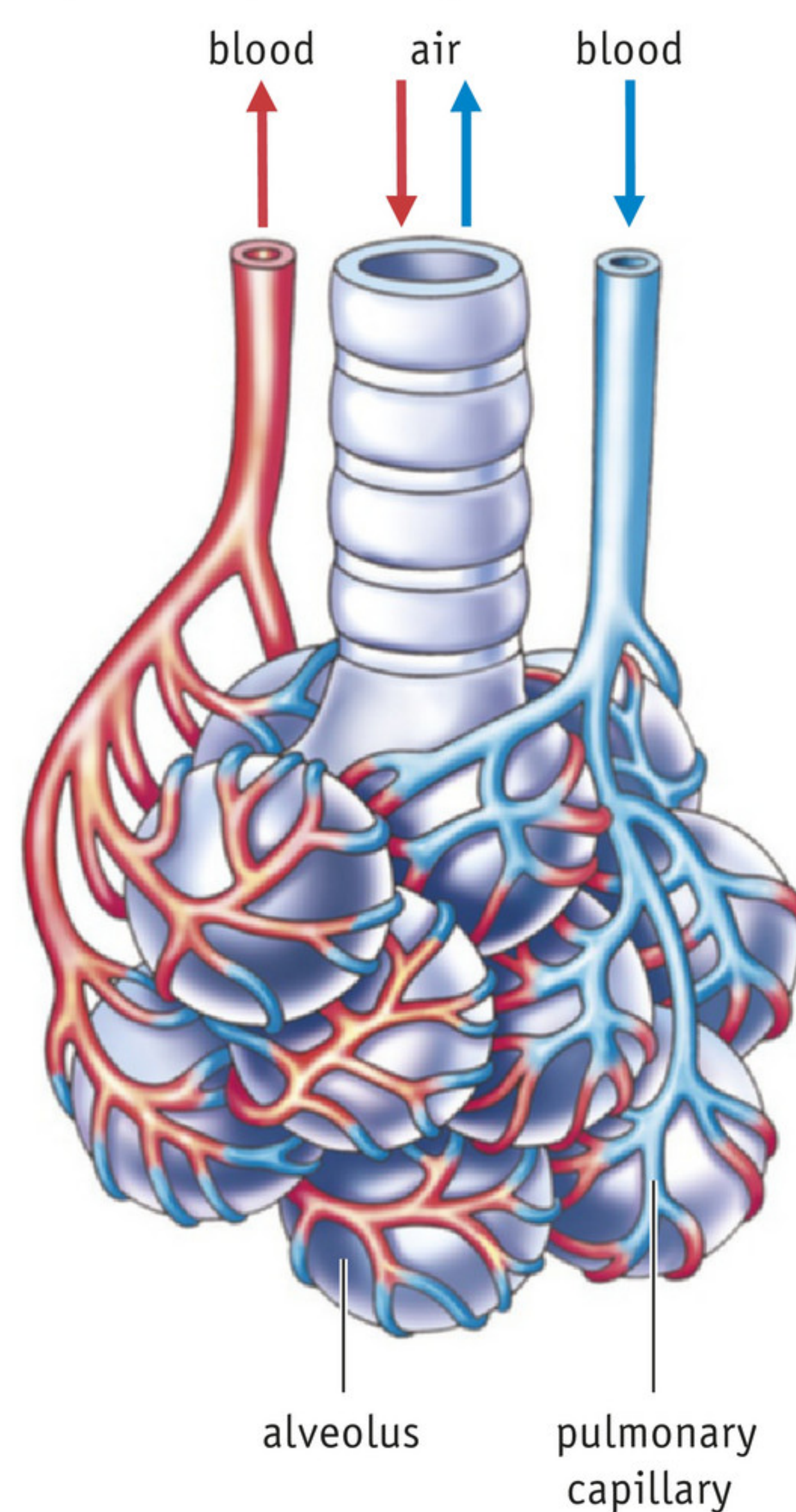


fig. 5 Alveoli with pulmonary capillaries (schematic).



KNOWLEDGE

1

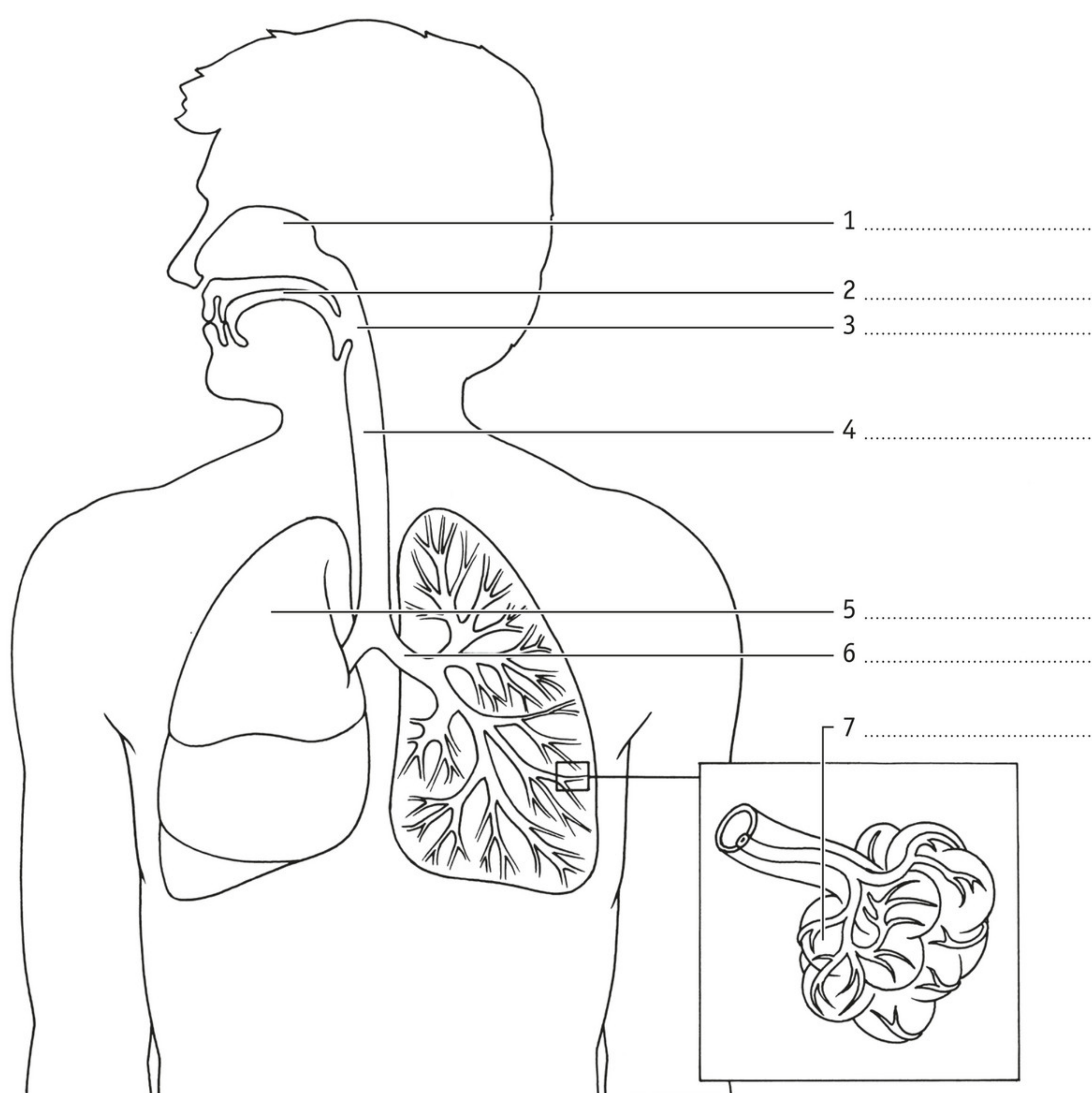


Figure 6 is a schematic representation of the human respiratory system.

- a Write down the names of the numbered parts.
- b Colour in the numbered parts. Use a different colour for each part.
- c Connect each part of the respiratory system to the correct function.

- | | | |
|------------|-----------------------|---|
| A bronchi | ☐ | ☐ 1 transporting air in and out through the bronchi |
| B alveoli | ☐ | ☐ 2 transporting air in and out through the bronchioles |
| C windpipe | ☐ | ☐ 3 exchanging oxygen and carbon dioxide with the blood |

fig. 6



2

You breathe out.

What order does the air pass through the parts of the respiratory system in?

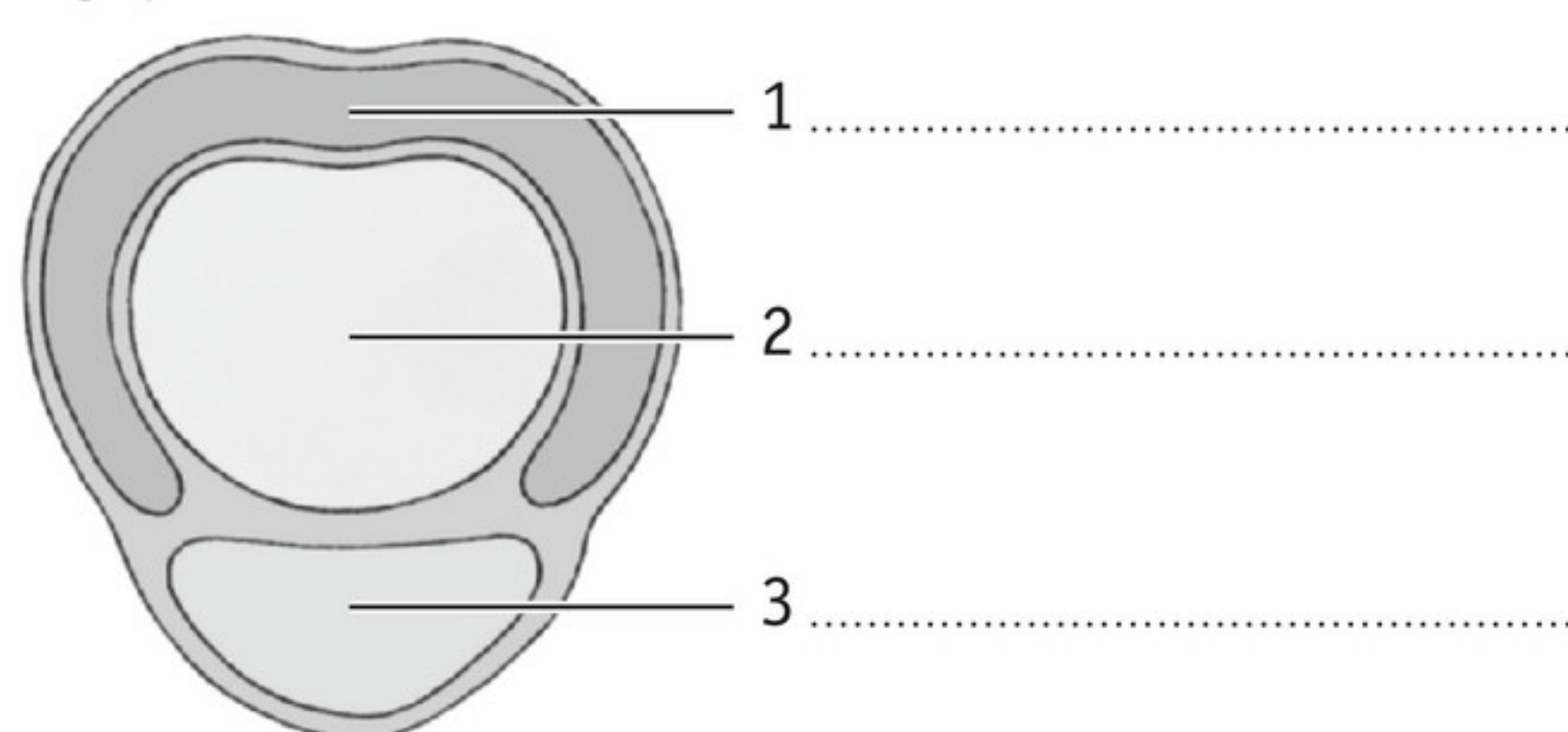
- bronchi
- pharynx
- alveoli
- windpipe
- bronchioles
- nasal cavity

3

Figure 7 shows a schematic cross-section of the windpipe and the oesophagus.

- a** Write down the names of the numbered parts.
- b** Which part contains the mucus lining with cilia?
- ☐ A part 1
- ☐ B part 2
- ☐ C part 3
- c** What is the function of part 1?

fig. 7



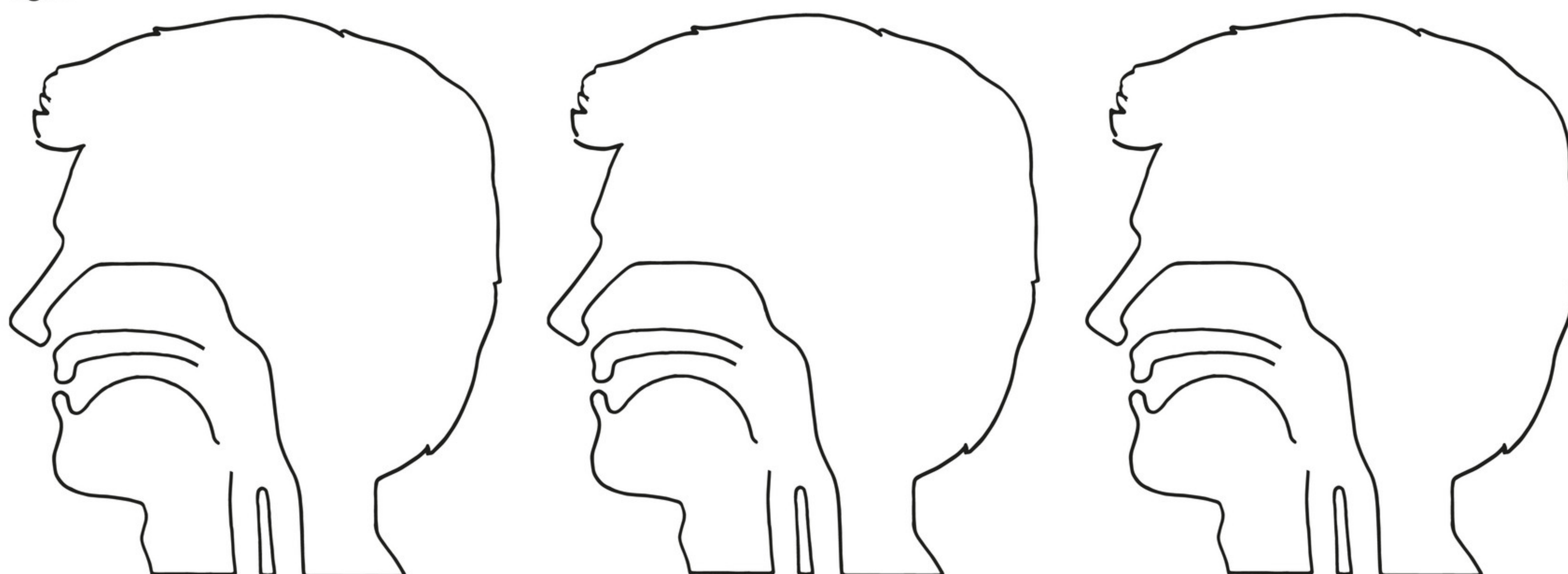
4



Food and air both pass through the pharynx.

- a** Figure 8 shows three schematic drawings of the pharynx.
- Show the direction of the air in drawing 1 when inhaling. Draw the uvula and the epiglottis in the correct position.
 - Show the direction of food in drawing 2 when swallowing. Draw the uvula and the epiglottis in the correct position.
 - Show the direction of food in drawing 3 when choking. Draw the uvula and the epiglottis in the correct position.

fig. 8



1 path taken by air when inhaling

2 path taken by food when swallowing

3 path taken by food when choking

- b** When you breathe through the nose, the nasal cavity is *open / closed* and the windpipe is *open / closed*.
 When you swallow food, the nasal cavity is *open / closed* and the windpipe is *open / closed*.
 When you choke on food, the nasal cavity is *open / closed* and the windpipe is *open / closed*.

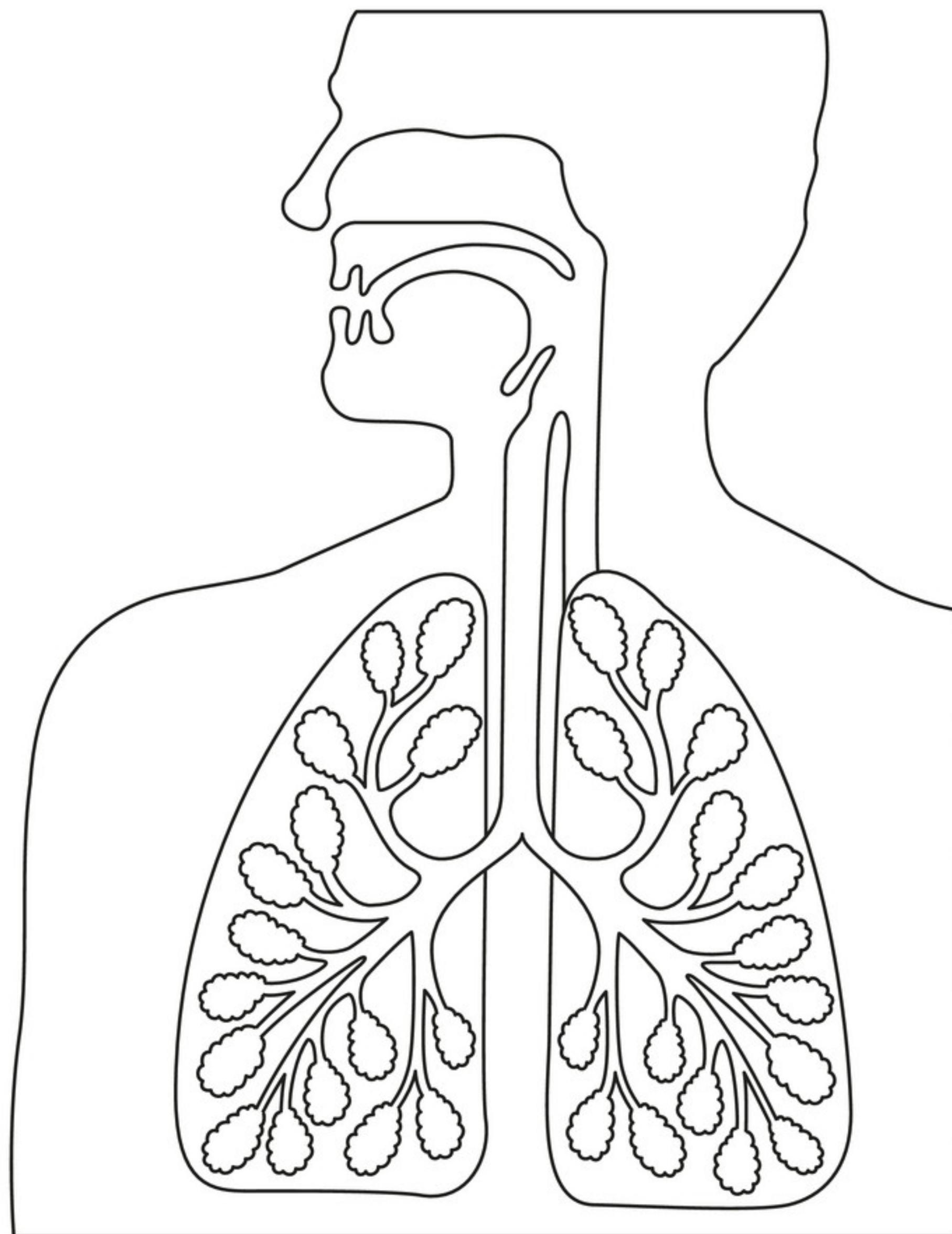
5

**Summary**

Make a summary using figure 9. This drawing shows you the respiratory system.

- Use arrows to show the route taken by the air.
- Write down the name and function (if applicable) for each part.

fig. 9

**INSIGHT**

6

Inflammation of the epiglottis sometimes occurs in infants and young children. This makes the epiglottis swell.

What might the consequence of a swollen epiglottis be?

7

Natural gas does not have a smell. An aromatic substance is added to natural gas before it gets used as fuel in ovens and heating boilers.

a Explain why this is done.

b Some people always breathe through the mouth.

Explain why respiratory tract inflammations are more common among children who always breathe through the mouth than in children who breathe through the nose.

8

When swimming underwater, you can use a snorkel to breathe (see figure 10). What are the disadvantages of breathing through a snorkel? Write down at least three.

fig. 10



+ 9

Q fever is an illness caused by the bacterium *Coxiella burnetii*. Goats and sheep in particular can be carriers of this bacterium. The bacterium spreads mostly through the air. During the lambing period, the bacterium gets into the air through amniotic fluid, milk, urine and faeces.

Q fever is a zoonosis, which means that the bacterium can spread from animals to humans. People get infected when they breathe in the bacterium. The bacteria can then cause liver inflammation, for instance. Transmission from one person to another is only possible by blood transfusions, though, or during childbirth from a woman who has Q fever.

- a** Can this bacterium pass through the walls of the alveoli when you breathe in? Explain your answer.
- b** Can this bacterium pass through the walls of the alveoli when you breathe out? Explain your answer.

HOW IT FITS TOGETHER the world we live in

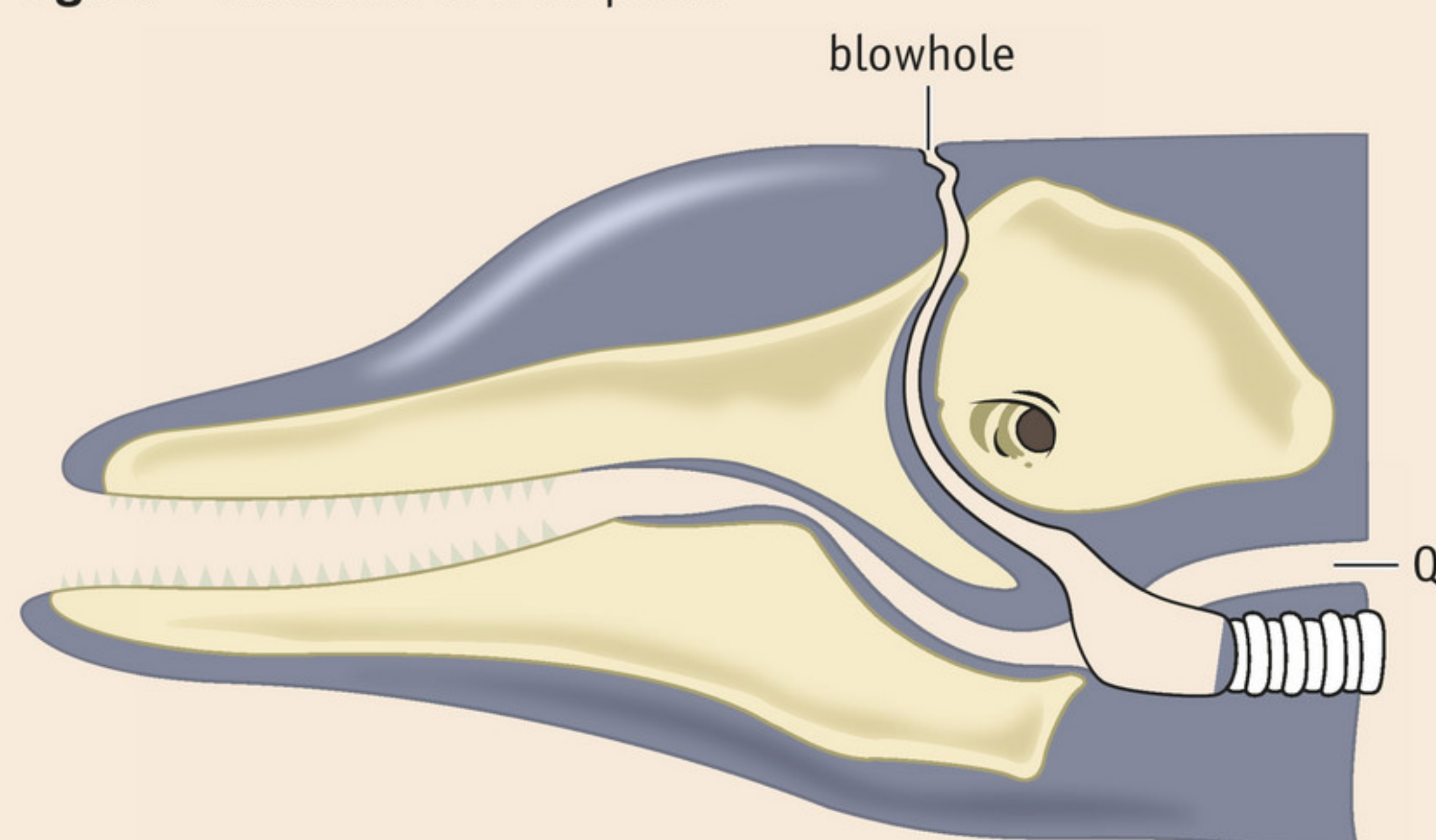
DOLPHINS

Dolphins live in the water but use lungs to breathe, just like humans. Dolphins have lungs because they are the descendants of mammals that lived on land millions of years ago.

Dolphins breathe through a blowhole that is on the top of their head. The blowhole has arisen from the nose of the mammals that they are descended from. You can compare it to your own nose.

When a dolphin goes under the water, the blowhole is closed. A dolphin that gets water in its blowhole can drown. A dolphin has to come to the surface to breathe. Because this has to continue day and night, a dolphin never goes completely to sleep. Dolphins let the two halves of their brain take turns to sleep. While they are asleep, they swim around calmly with one eye open. After about an hour, that eye closes and the other eye opens. They sleep like that for about eight hours a day.

fig. 11 The head of a dolphin.



10

Read the text 'Dolphins'.

- a** In figure 11, the *windpipe / oesophagus* is labelled with letter Q.
- b** Explain why a dolphin cannot breathe through its mouth.
- c** Explain why a dolphin never chokes.
- d** Which two parts of the human respiratory system does a dolphin not have?
- e** Because the blowhole only comes above water for a moment, dolphins have to breathe powerfully and quickly. When they breathe out, you can see water squirting up from the blowhole.

Explain why there is water in the exhaled air.

 Go to the *Flash cards* and the *Test yourself* section.

4 Breathing

LEARNING OBJECTIVES

1.4.6 You can state the differences between inhaled air and exhaled air.

► Practical activities 4, 5, 6

1.4.7 You can describe how inhalation and exhalation are achieved.

and 7

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES	
	1.4.6	1.4.7
Remembering		3a
Understanding	1, 4	2, 3bc, 4
Using	5, 6b, 10ab	8, 10c
Analysing	6a, 7b	7ab, 9, 10d

The air in your lungs needs to be refreshed continuously. This is done as you inhale and exhale. There are two ways of breathing in and out: using the chest muscles or the abdominal muscles.

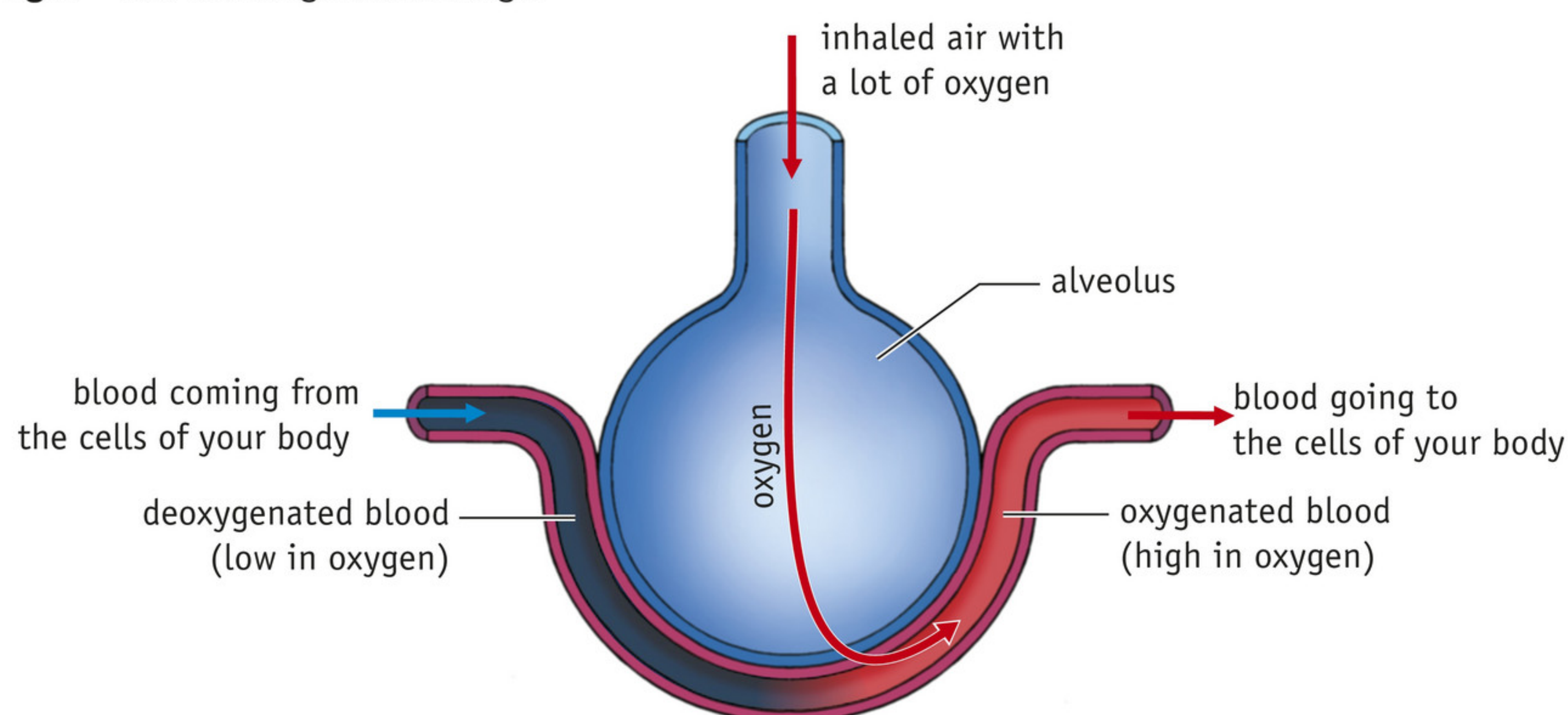
GAS EXCHANGE

The composition of the air that you breathe out (exhale) is not the same as the air you breathe in (inhale). When you breathe in, you absorb oxygen from the air (see figure 1.1). The oxygen is transferred from the air in an alveolus to the blood in the capillaries. The blood transports the oxygen to the cells where the oxygen is used for the combustion of glucose.

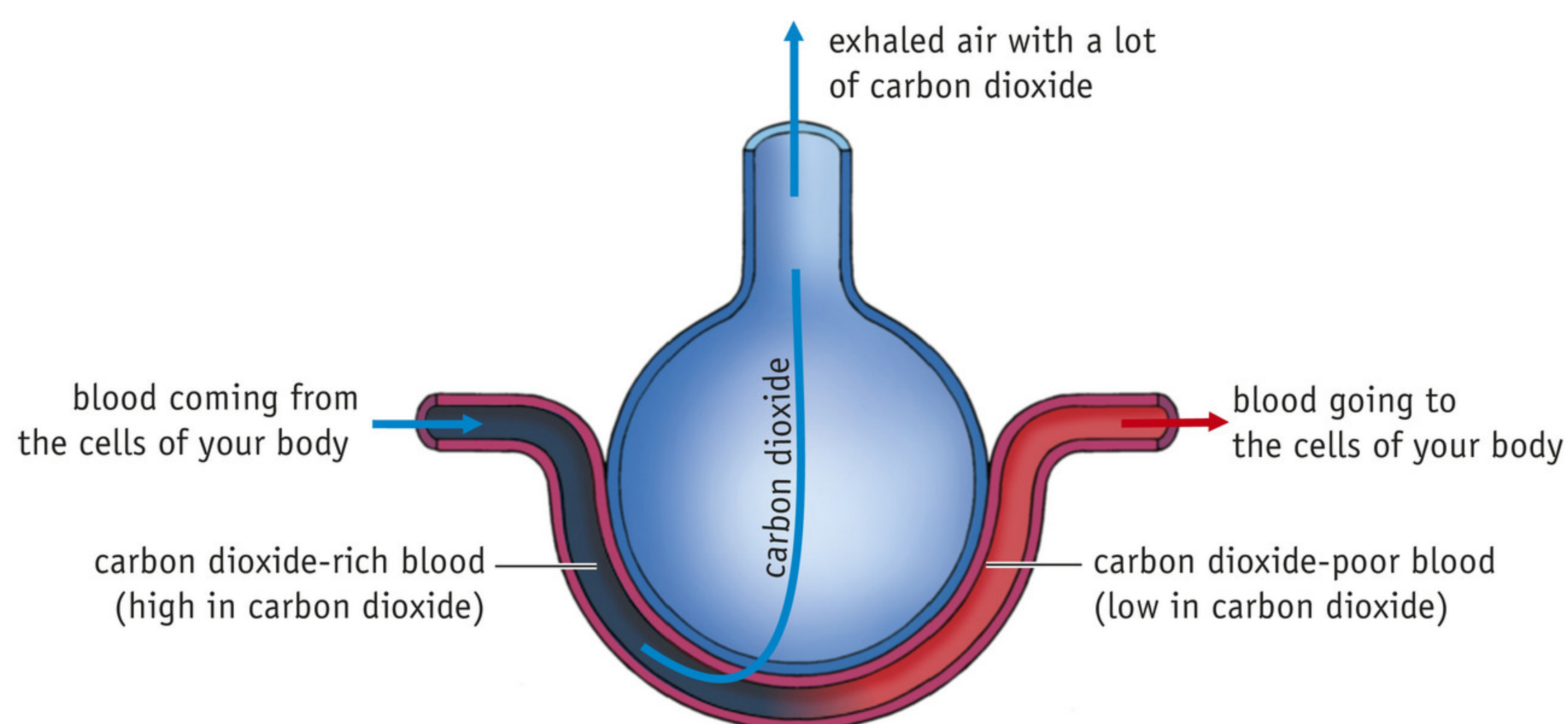
This combustion produces carbon dioxide and water. The blood absorbs these substances and carries them to the lungs. In the lungs, carbon dioxide from the blood passes from the capillaries into the air in the alveoli. When you breathe out, you are getting rid of carbon dioxide to the surrounding air (see figure 1.2). You also lose water and energy (heat) when you exhale.

The absorption and release of oxygen and carbon dioxide through the alveoli is called **gas exchange**. The thin walls and large surface area of the alveoli mean that gas exchange can happen rapidly (see figure 1). Blood flowing to the alveoli does not contain much oxygen but has a lot of carbon dioxide. Blood flowing away from the alveoli contains a lot of oxygen but not much carbon dioxide.

fig. 1 Gas exchange in the lungs.



1 uptake of oxygen



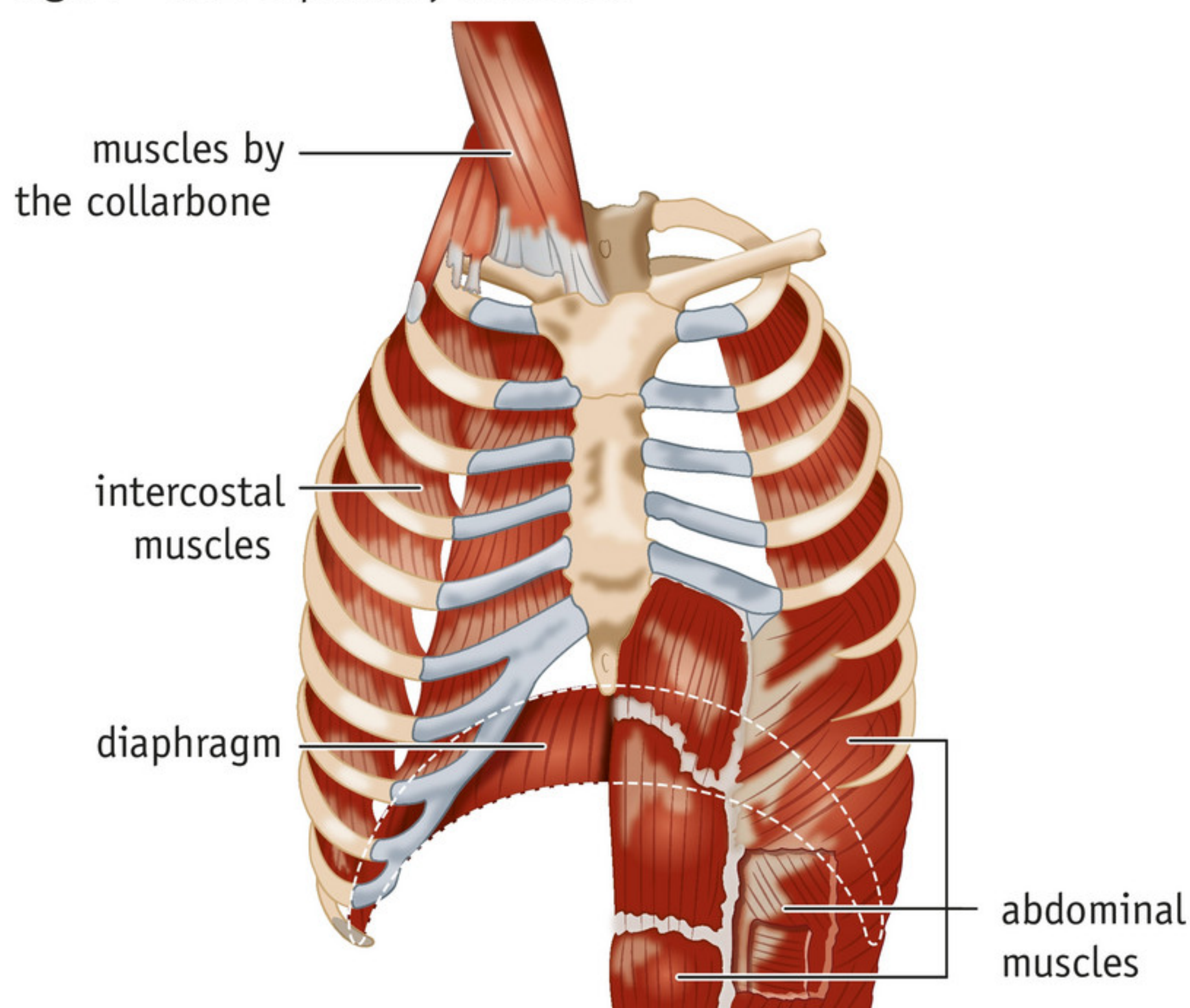
2 release of carbon dioxide

CHEST BREATHING

You breathe using the **respiratory muscles**. Those are the diaphragm, the abdominal muscles, the intercostal muscles and (when you breathe in deeply) the muscles near the collarbone (see figure 2).

Normal, calm breathing consists of both chest breathing and abdominal breathing. In **chest breathing** (thoracic breathing), the ribs and the breastbone move. The ribs are attached to the spinal column by joints. They are attached to the breastbone by cartilage. These joints let the ribs and the breastbone move.

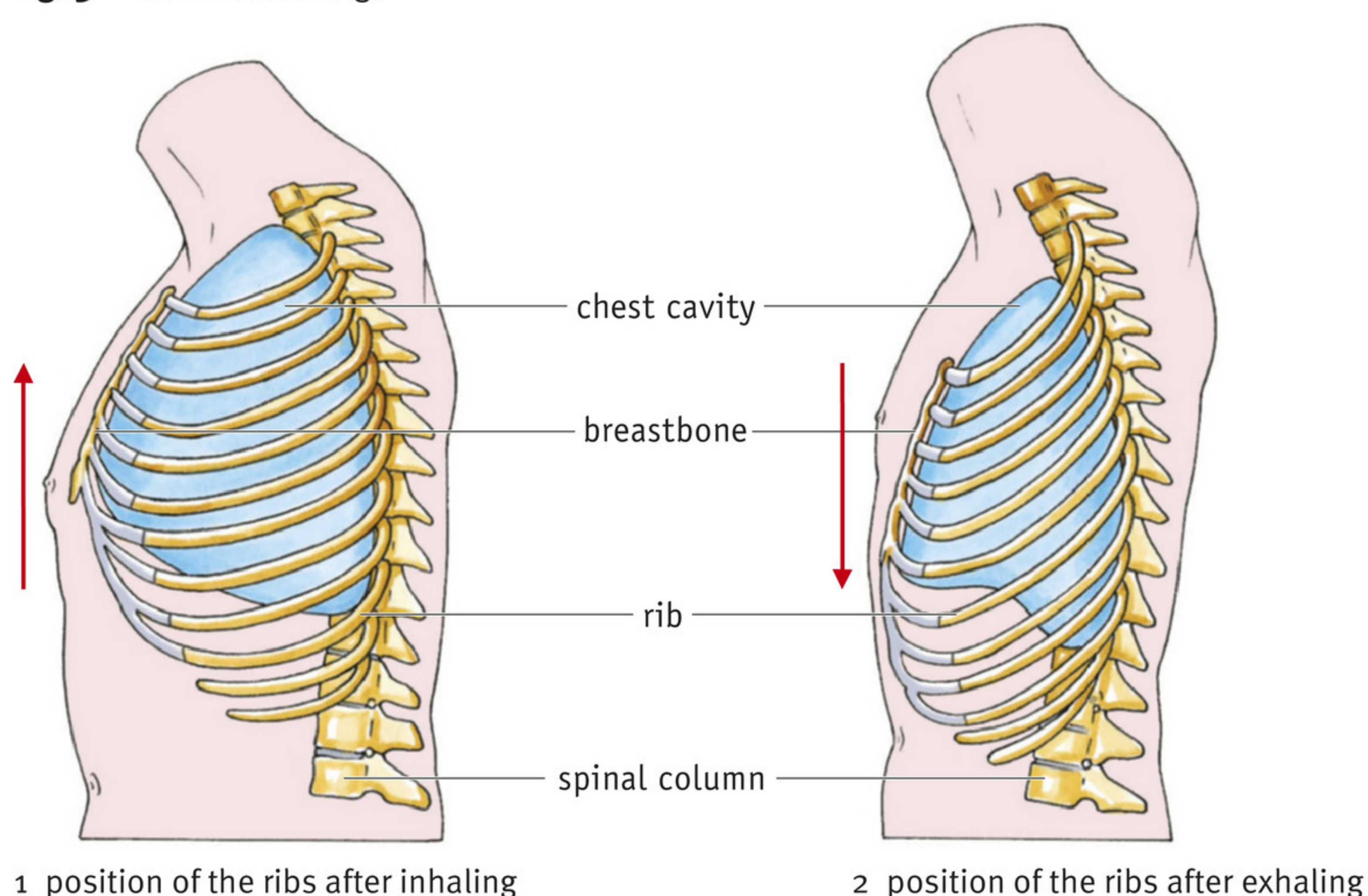
fig. 2 The respiratory muscles.



When you breathe in, the intercostal muscles tense. This moves your ribs and breastbone up so that the chest cavity becomes larger (see figure 3.1). Your lungs are made to expand. Because your lungs are getting larger, air is drawn into them.

When the intercostal muscles relax, your ribs and breastbone move downwards (see figure 3.2). This makes your chest cavity and lungs smaller again. Making your lungs smaller means that air is forced out of them: you exhale.

fig. 3 Chest breathing.

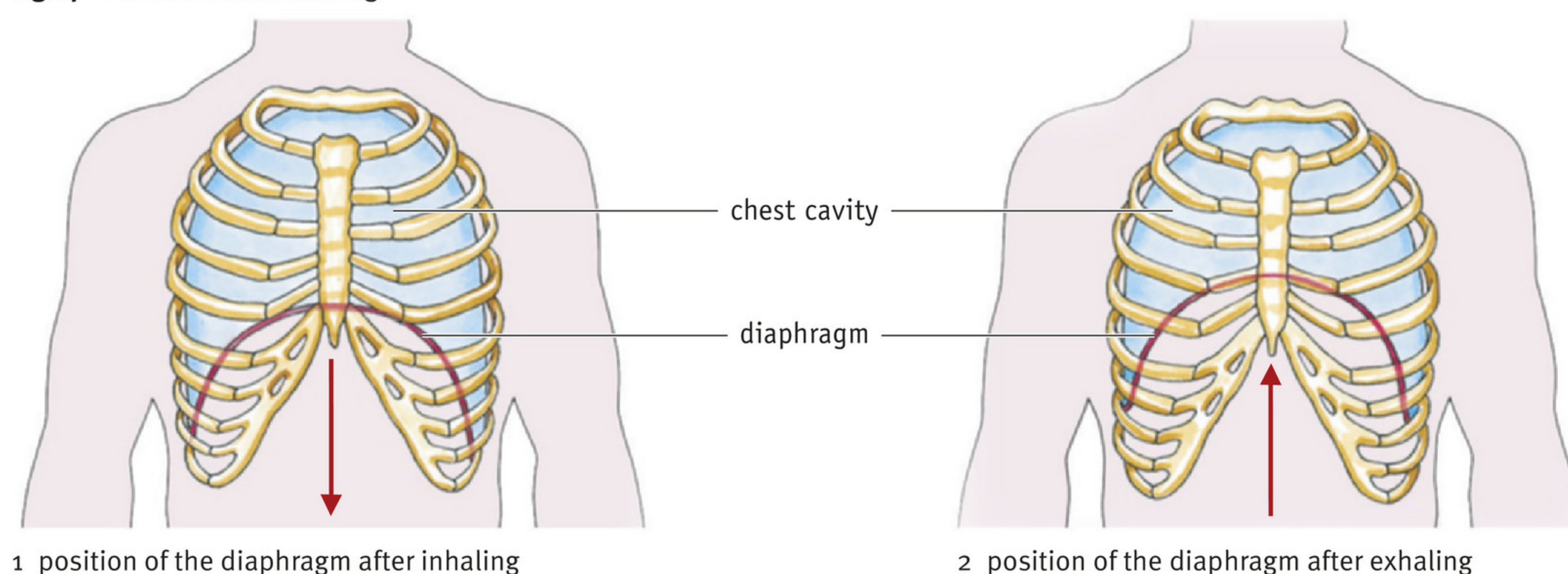


ABDOMINAL BREATHING

In **abdominal breathing** (diaphragmatic breathing), the diaphragm and abdominal wall move. The diaphragm contracts, making it move downwards (see figure 4.1). This makes your chest cavity larger. Your lungs are then made to expand so that air flows into them: you inhale. When the diaphragm moves downwards, the organs in the abdominal cavity are pushed aside. Those organs can only move forwards and so they push the abdomen outwards.

When you relax your diaphragm, it moves upwards (see figure 4.2). The abdominal wall moves back to its normal position and your chest cavity and lungs become smaller.

fig. 4 Abdominal breathing.



KNOWLEDGE

1

Figure 5 shows a cluster of alveoli with a pulmonary capillary around them. Arrows 1 and 2 show the air flowing in (1) and out (2). Arrows 3 and 4 show the blood that is flowing into the alveoli (3) and the blood that is flowing away from the alveoli (4). All the blood vessels have been drawn in red, irrespective of whether they contain blood with a lot of oxygen or not. Complete sentences. Choose between: *a lot of* – *only a little*.

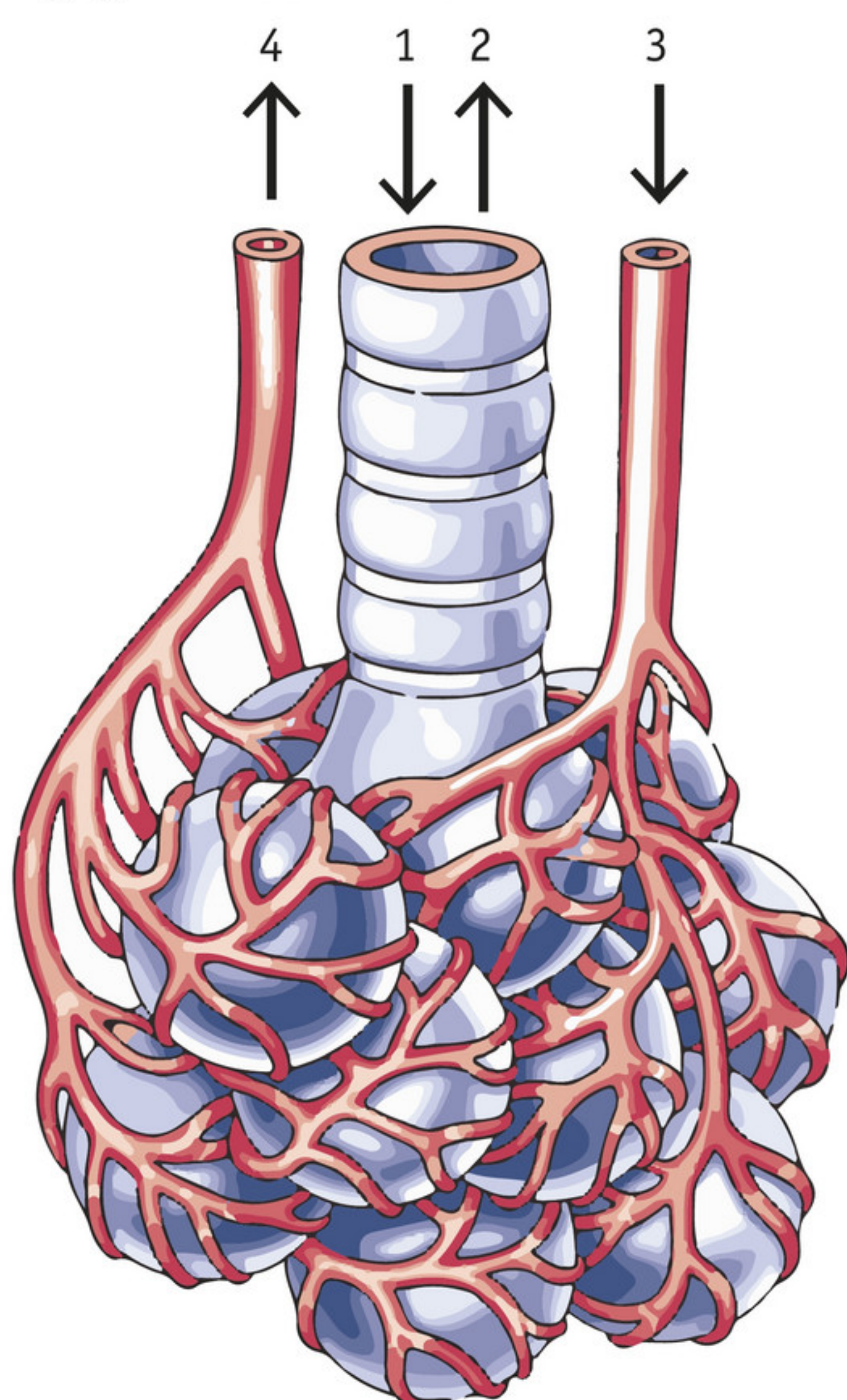
The air at arrow 1 contains oxygen and carbon dioxide.

The air at arrow 2 contains oxygen and carbon dioxide.

The blood at arrow 3 contains oxygen and carbon dioxide.

The blood at arrow 4 contains oxygen and carbon dioxide.

fig. 5 A cluster of alveoli.



2

Chest breathing and abdominal breathing are two different ways of breathing.

a Put these events in the correct sequence for inhaling.

- the chest cavity gets larger
- the lungs get larger
- air flows into the lungs
- the ribs and breastbone move up

b Put these events in the correct sequence for exhaling.

- the chest cavity gets smaller
- the lungs get smaller
- air flows out of the lungs
- the ribs and breastbone move down

c Do the events in questions (a) and (b) refer to chest breathing or abdominal breathing? Explain your answer.

3

- a** What type of breathing is normal for someone at rest?
- ☐ A chest breathing
 - ☐ B abdominal breathing
 - ☐ C alternating chest breathing and abdominal breathing
 - ☐ D chest breathing and abdominal breathing at the same time
- b** When you contract your diaphragm, the lungs get *larger* / *smaller* so that you *inhale* / *exhale*. This movement occurs in *chest breathing* / *abdominal breathing*.
- c** Contracting the intercostal muscles lets you move your ribs *upwards* / *downwards* and the chest cavity becomes *larger* / *smaller*. This movement occurs in *chest breathing* / *abdominal breathing*.

4

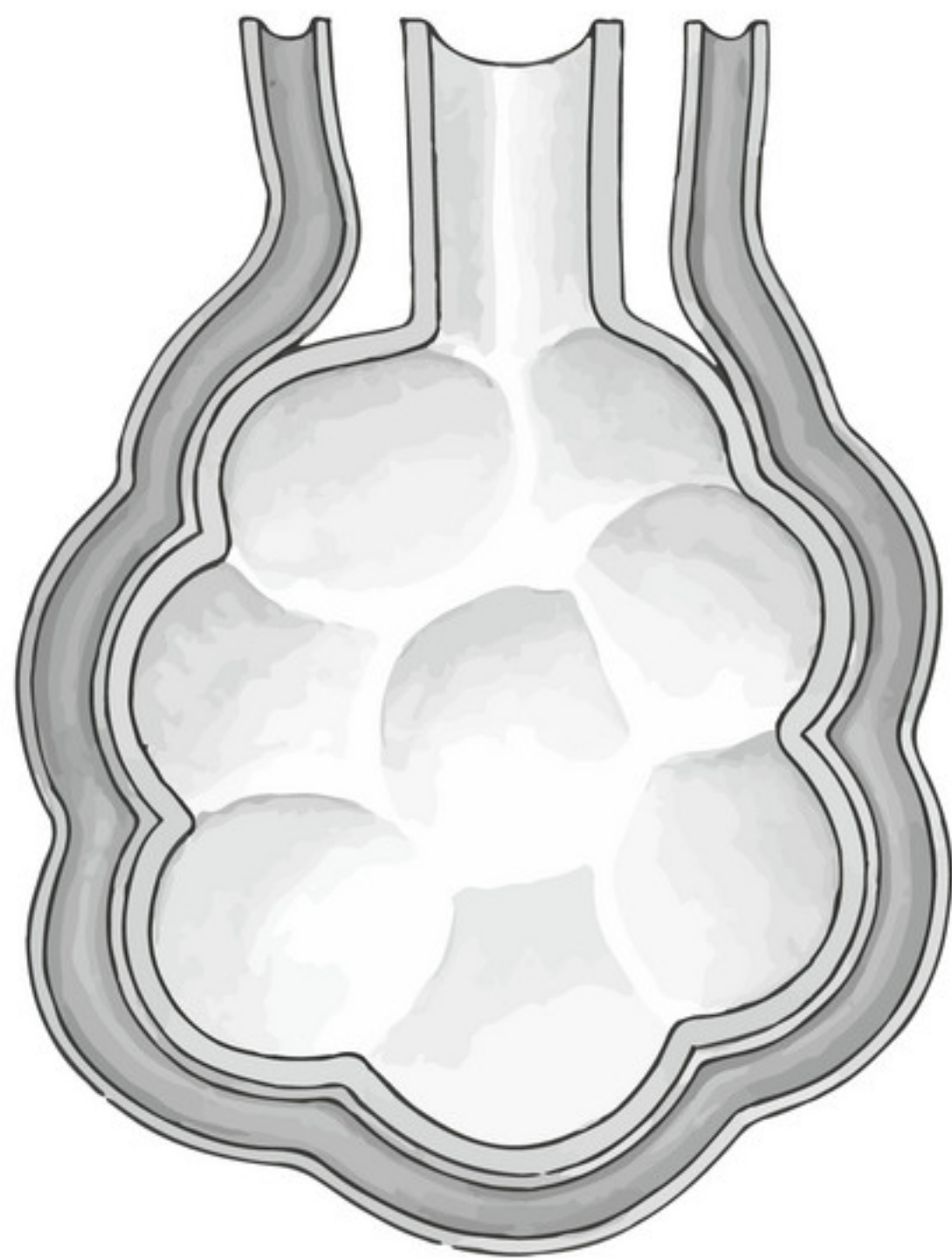


Summary

Make a summary using figure 6. This drawing shows you an alveolus with a pulmonary capillary.

- Use arrows to show which directions the blood and air are flowing in.
 - Use arrows to show how oxygen and carbon dioxide are exchanged.
 - Write down the differences between the inhaled and exhaled air.
- Next to the drawing, describe the steps in chest breathing and abdominal breathing.

fig. 6



The steps in chest breathing:

.....

.....

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The steps in abdominal breathing:

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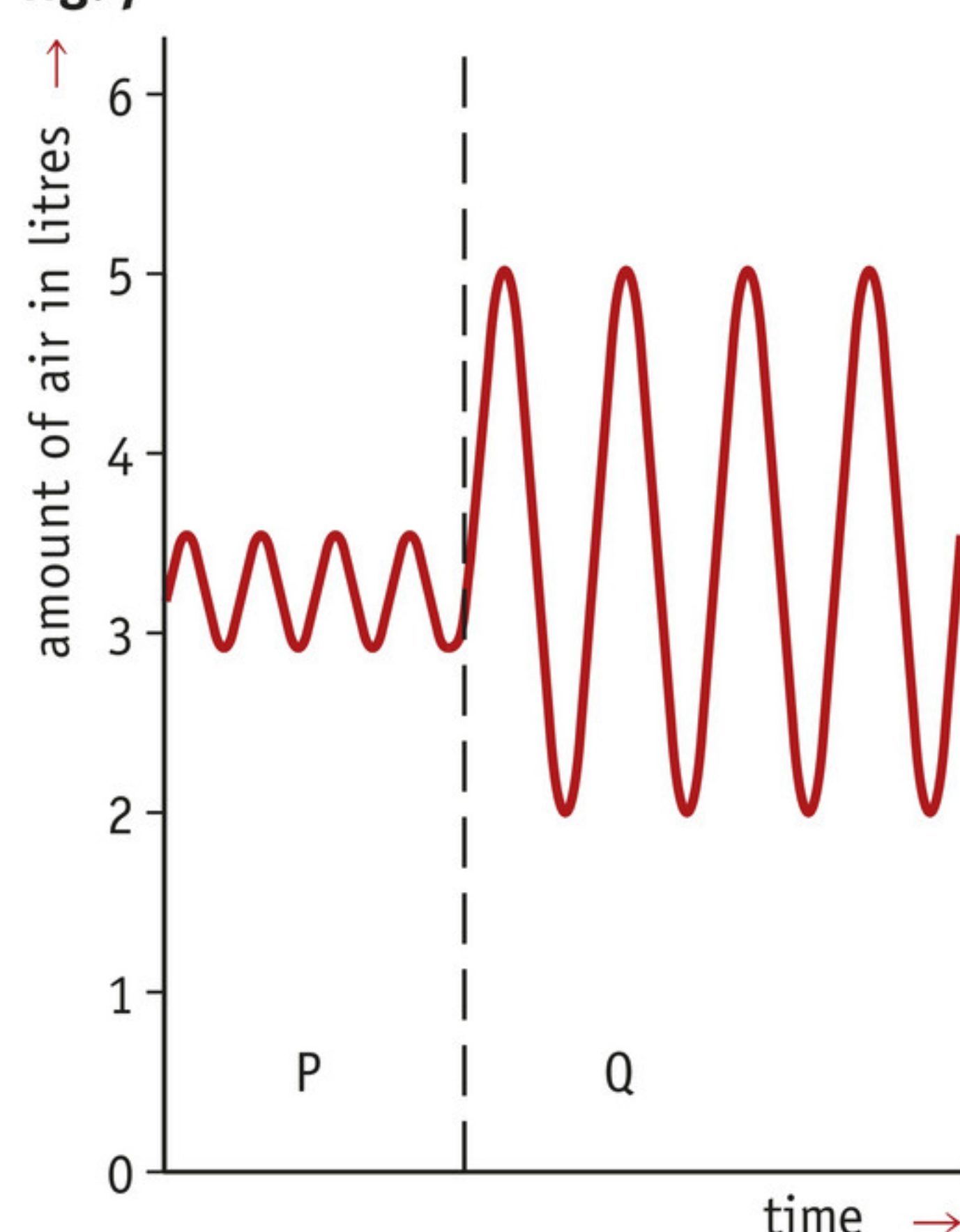
INSIGHT

5

Measurements were made on Alex for a while to see how many litres of air there are in his lungs. The results of those measurements have been processed in the diagram of figure 7.

Explain how you can tell from the diagram which interval (P or Q) had more combustion taking place in Alex's body.

fig. 7



6

Air is a mixture of various gases.

- a Does exhaled air contain the same amount of nitrogen as inhaled air? Explain your answer.
- b Which air is warmer: the air that you breathe in or the air that you breathe out? Explain your answer.

7

Researchers have examined the skeletons of Neanderthals. This type of prehistoric human died out around fifty thousand years ago. The researchers discovered that the ribcage of a Neanderthal was about the same size as our own, but that the lower part of it was wider among Neanderthals than in us.

- a Was gas exchange quicker, the same or slower in Neanderthals than in us? Explain your answer.
- b Figure 8 shows you a reconstruction of the head of a Neanderthal and the head of a modern human.
Under normal conditions, you breathe through your nose. If you are exerting yourself a lot, you breathe through your mouth. Neanderthals were able to exert themselves more than modern humans without having to breathe through the mouth.
What feature tells you that?

fig. 8 Neanderthal and modern human.



8

Sammy has a cold. It is making him cough a lot. Coughing needs you to exhale forcefully. Try this for yourself and see which muscles you tense.

- a** Say which muscles contract powerfully in coughing.
- b** Which muscles are the antagonistic muscles to the abdominal muscles in abdominal breathing?
- ☐ A the pectoral muscles
 - ☐ B the back muscles
 - ☐ C the intercostal muscles
 - ☐ D the diaphragm

+ 9

Figure 9 shows a model that simulates the movements of the ribs and the breastbone. P, Q, R and S represent attachment sites of intercostal muscles.

- a** A muscle that contracts during inhalation runs:
- ☐ A from P to Q
 - ☐ B from P to R
 - ☐ C from P to S
 - ☐ D from S to Q
 - ☐ E from S to R
- b** When you relax the chest muscles, gravity makes sure that the ribcage compresses the lungs and so you breathe out. Gravity does not have that effect, however, in a circus artiste who is hanging upside down from a trapeze (see figure 10). In this case, intercostal muscles have to contract to make the ribcage smaller again. Which intercostal muscle has to contract to make the ribcage of a trapeze artiste who is hanging upside down smaller again?
- ☐ A from P to Q
 - ☐ B from P to R
 - ☐ C from P to S
 - ☐ D from S to Q
 - ☐ E from S to R

fig. 9

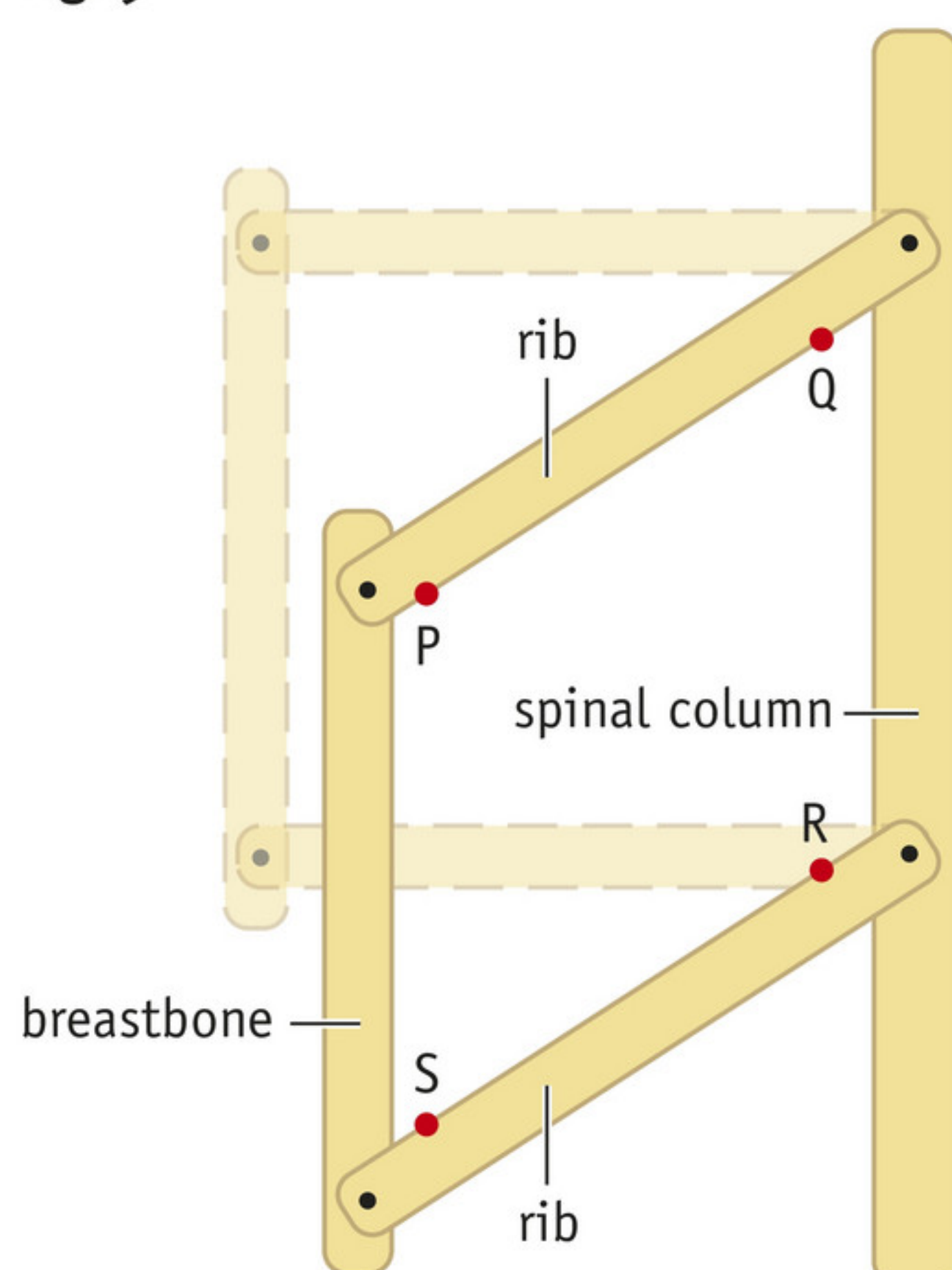


fig. 10 A trapeze artiste.



HOW IT FITS TOGETHER the world we live in

MOUTH-TO-MOUTH RESUSCITATION

Accidents sometimes happen. Even at school. What should you do if one of your classmates faints? Or if someone chokes on a swig of a soft drink? To deal with accidents like these correctly, there are members of staff at every school who have followed a First Aid course. That could be anyone from the janitor to the PE teacher. You can take that kind of course too. The Red Cross gives courses throughout the country for various target groups. There is also a first aid course for secondary school pupils, for example. A Red Cross instructor then comes to the school to give courses. When it is completed, the pupils get a First Aid certificate.

If you want to get a diploma, you need to take a course that lasts rather longer. One of the first things you learn is how to give mouth-to-mouth resuscitation. Mouth-to-mouth resuscitation is first aid that is given to people who are no longer able to breathe themselves.

fig. 11 Mouth-to-mouth resuscitation.



10

Read the text 'Mouth-to-mouth resuscitation'.

In mouth-to-mouth resuscitation, the first aider blows exhaled air into the lungs of the victim.

- a** Does the air that the victim inhales then contain more or less oxygen or the same amount as the air that the first aider has breathed in? Explain your answer.
- b** Does the air that the victim exhales then contain more or less carbon dioxide or the same amount as the air that the first aider breathed out? Explain your answer.
- c** Put the events when someone is being ventilated in the correct sequence.
 - the lungs get larger
 - air flows into the lungs
 - the ribs and breastbone move up
- d** Figure 11 shows you a first aider ventilating a victim. The first aider pinches the victim's nose closed when they do that. Explain why the victim's nose is pinched closed.

 Go to the *Flash cards* and the *Test yourself* section.

5 Healthy airways

LEARNING OBJECTIVES

- 1.5.8 You can explain what you can do for yourself to keep your airways healthy.

1.5.9 You can describe what hay fever is.
- Learning how to do research 3

► Practical activity 8

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES		
	1.5.8	1.5.9	1.2.3*
Remembering	1	2ab	
Understanding	3, 4	2cde, 4	
Using	5, 7, 8, 9, 11ace	10	
Analysing	11bd	6	11b

* You can find this learning objective in another Basics section.

Various factors can mean that the lungs and airways function less well. People can then get short of breath or may need to cough a lot. There are things that you can do for yourself to keep your airways healthy.

CLEAN LUNGS

The most important thing that you can do for yourself to keep your respiratory tract clean is not to start smoking. Tobacco smoke contains thousands of substances that can be harmful to the lungs. At least forty of those substances are also carcinogenic. The smoke of a cigarette contains (among other things) very small droplets of tar. That tar damages the inside of the respiratory tract (see figure 1). Using electronic cigarettes or bongs is bad for the lungs too. Damaged lungs are less good at absorbing oxygen. It means that you are less able to exert yourself physically: you become less fit.

fig. 1 This is what smoking does to your lungs.



1 healthy lungs

2 a smoker's lungs

MOVING AND SINGING

Plenty of exercise is good not only for your fitness but also for the health of your lungs. Playing sports and exercise improve your condition and will make your lungs stronger. For major physical efforts, your body needs a lot of oxygen and you then breathe more deeply. Sports thereby strengthen the respiratory muscles and increase your lung capacity. Singing and playing wind instruments can also help make your lungs stronger. They are both good forms of breathing exercises that will improve your fitness.

But do be careful if there is a lot of **smog** in the air. Smog is a type of air pollution that consists largely of fine particulates. It is more likely to occur when there is not much wind. The fine particulates and other air pollution are not blown away so well then. It is better not to play sports outdoors if there is a lot of smog. If you do then want to be active outdoors, it is best to do that early in the morning or late in the evening, because the air is generally cleaner then.

fig. 2 Exhaust gases create air pollution.



FRESH AIR

Fresh air is also very important in the home and in the classroom. If a group of thirty pupils sit in a classroom for hours, the amount of carbon dioxide in the air in the classroom will go up sharply. Other substances can build up too, as well as the level of oxygen going down. If there is not enough fresh air, you may start to lose concentration, get headaches or feel fatigued. Bacteria and viruses are also able to spread more easily.

Ventilation replaces the 'old' air with fresh air. So make sure there is always enough **ventilation**. Open the ventilation grilles or open the window a crack. Freshen the air in the classroom every day as well by opening the window wide for half an hour. You can use a carbon dioxide meter (see figure 3) to measure whether the air quality in the classroom is good enough.

fig. 3 A carbon dioxide monitor.



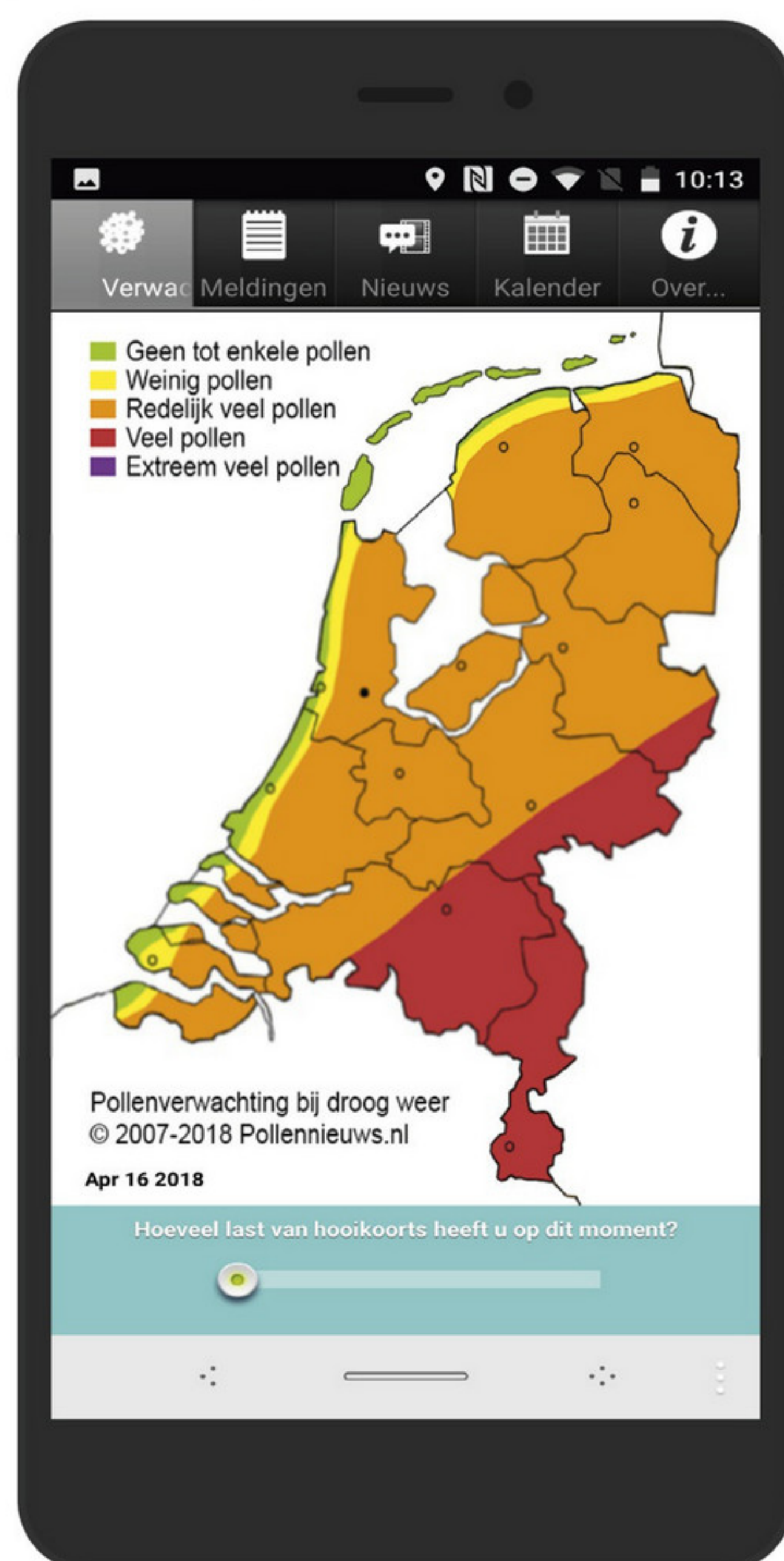
HAY FEVER

Wind-pollinated flowers produce large numbers of lightweight pollen grains that are blown away by the wind. There are some days in the spring and summer when the air is full of pollen. In the spring it is mostly pollen from trees and shrubs. The pollen in the summer is mostly from grasses and herbaceous plants. You then breathe that pollen in. The pollen grains then stick to the mucous lining in your airways.

Some people are unable to cope when the pollen of certain plants gets into contact with the mucous membranes of their airways. They get a burning or itchy feeling in the nose, throat and eyes. The lining can then also start to swell up because of inflammation. These people are suffering from hay fever. **Hay fever** is the commonest form of allergy. An allergy is when you are hypersensitive to particular substances.

People with hay fever sometimes keep sneezing for hours at a time, so it's best for them to avoid pollen as much as possible. Information about how much pollen is in the air can be found on the Internet. There are also apps with information about pollen and hay fever (see figure 4).

fig. 4 Information about pollen via your mobile phone.



KNOWLEDGE

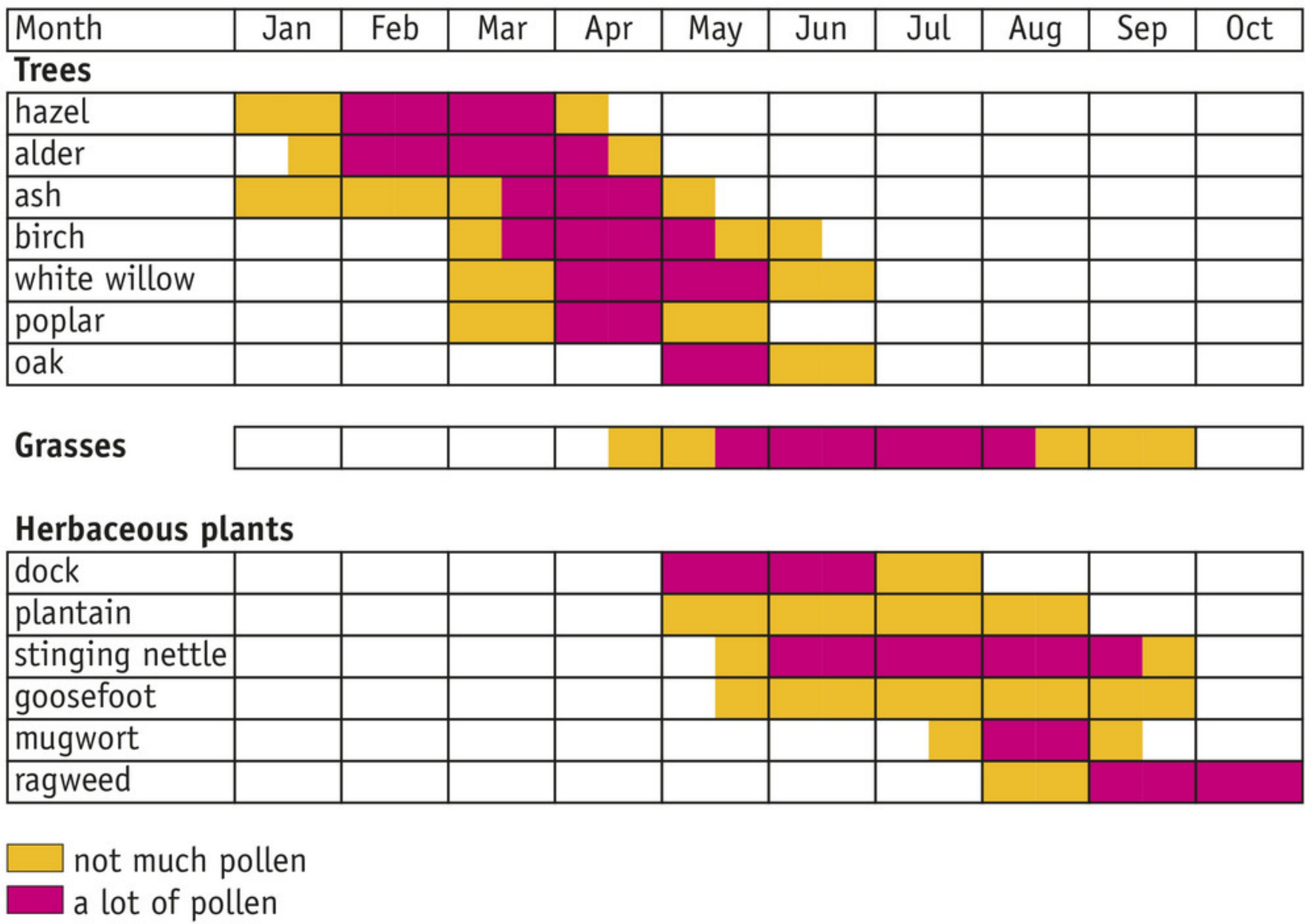
1

- a What creates smog?
- ☐ A Lots of fine particulates in the air.
 - ☐ B Too much carbon dioxide in the air.
 - ☐ C Too little moisture in the air.
 - ☐ D Too little oxygen in the air.
- b Smog happens in particular when there is *a lot of / not much* wind.

2

- Hay fever is an example of an allergy.
- a What is an allergy?
- b Hay fever is caused by pollen that is spread by *the wind / insects*.
- c Figure 5 shows a pollen calendar. A pollen calendar shows when all kinds of plants are producing pollen. Ryegrass is a common species of grass. Pollen from this plant gives many people hay fever. In which month is the risk of hay fever highest for those people?
- ☐ A April
 - ☐ B May
 - ☐ C July
 - ☐ D August
- d Kevin only suffers from hay fever in September and October. His hay fever is caused by pollen.
- e Weather conditions can be favourable or unfavourable for hay fever sufferers. Which weather forecast would lead to them being advised to stay indoors?
- ☐ A Cloudy but dry, with a light wind from the south. Maximum temperature 10 °C.
 - ☐ B Rain all day and almost no wind. Maximum temperature in the afternoon of 12 °C.
 - ☐ C Mainly cloudy with occasional rain and a light wind from the west. Maximum temperature about 16 °C.
 - ☐ D Dry and sunny with quite a strong wind from the south. Maximum temperature in the afternoon of about 23 °C.

fig. 5 Example of a pollen calendar.



3

Explain why your respiratory muscles are made stronger by sports, singing and playing wind instruments.

4



Summary

- How do you keep your lungs clean?
- How do you make your lungs strong?
- What is hay fever? What causes it and what are the symptoms?

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INSIGHT

5

Cigarette smoke contains small droplets of tar. Tar cannot get through the alveolar walls and remains in the alveoli.
Explain how that affects the gas exchange.

6

Figure 4 shows you an app with information about pollen and hay fever,
Explain why people who live on the Wadden Islands are less affected by hay fever than people who live in Limburg.

7

In a classroom where all the windows are closed, many pupils can be affected by poor concentration and fatigue.

a Explain why these complaints can arise in that classroom.

b You can provide ventilation by opening the windows.

The oxygen level of the outside air is *higher / lower* than for the air in the classroom.
That means that air containing more oxygen will flow *in / out*.
The carbon dioxide level of the outside air is *higher / lower* than for the air in the classroom. That means that air containing more carbon dioxide will flow *in / out*.

8

Asthma is a chronic lung disease (one that does not go away with time). People with asthma are often short of breath. That shortness of breath mostly starts suddenly and it is therefore often called an 'asthma attack'. An attack is caused by specific triggers, such as dust in the air, tension or stress. The walls of the bronchioles have small muscles. In an asthma attack, the muscles in the walls of the bronchioles contract.

- a** Explain why an asthma patient gets less oxygen into their lungs during an asthma attack.
- b** Explain what effect an asthma attack has on gas exchange.
- c** One in ten schoolchildren has asthma.
Explain why keeping classrooms clean can be so important for them.

9

COPD is an inflammation of the respiratory tract that does not go away with time. Smoking is the main cause of COPD. In COPD, the mucous lining of the inside of the respiratory tract is inflamed, so that it swells up and starts producing more mucus.

- a** Explain why people with COPD cough a lot.
- b** Explain why someone feels short of breath if the mucus lining of the respiratory tract swells up.
- c** In COPD, some alveoli may be lost. This is called pulmonary emphysema.
In pulmonary emphysema, the gas exchange surface in the alveoli is *larger / smaller*.
As a result, *more / less* oxygen and *more / less* carbon dioxide can be exchanged between the alveoli and the blood.

+ 10

There are various remedies you can buy to reduce the symptoms of hay fever. Explain whether a hay fever remedy is an antibiotic or not.

HOW IT FITS TOGETHER science

BAGPIPER'S LUNG

In 2014, a man aged 61 went to his doctor with a dry cough and shortness of breath. His condition worsened, despite treatment: in the end, he was not able to walk more than twenty metres without having great difficulty getting his breath. He was admitted to hospital and the diagnosis was made there: allergic alveolitis.

Allergic alveolitis is an inflammation in and around the alveoli, caused by an allergic reaction to inhaled dust particles, chemicals or allergens (substances that can trigger an allergic reaction). The inflammation can damage the lungs severely and can sometimes even be fatal. The condition particularly affects people who keep birds, particularly pigeons.

It was not clear why this man had the illness: he did not own any pigeons, there were no moist and mouldy areas in his house and he had never smoked. The man did however play the bagpipes every day. When the man went to Australia for three months, the bagpipes stayed at home and his condition improved visibly. That got the doctors thinking: could the bagpipes be causing it? They decided to take a closer look at the bagpipes and discovered that the instrument was full of a variety of species of moulds.

Source: www.scientias.nl.

fig. 6 Bagpipers.



11

Read the text 'Bagpiper's lung'.

- a** What was the bagpiper allergic to?
- b** The bagpiper had an inflammation in and around the alveoli. As a result, he had difficulty breathing and could barely walk twenty metres.
Explain why shortness of breath and lack of energy are the consequences of inflammation of the alveoli.
- c** The lungs are a good living environment for moulds. Explain why.
- d** A fungal infection is not treated with antibiotics. In fact, antibiotics can make the symptoms worse. Explain why.
- e** The condition affecting the bagpiper also occurs in people who work in spaces where lots of moulds are present.
What can these people do to reduce the amount of moulds?

 Go to the *Flash cards* and the *Test yourself* section.

6 Breathing in animals

LEARNING OBJECTIVE

1.6.10 You can describe how gas exchange occurs in various different groups of animals. ► Practical activities 9 and 10

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES		
	1.6.10	1.1.2*	1.2.3*
Remembering	1b, 3b		
Understanding	1a, 2, 3a, 4		
Using	5, 6, 7, 10ab	10ab	10ab
Analysing	8, 9, 10c		

* You can find this learning objective in another Basics section.

All organisms absorb substances from their surroundings and emit substances again. It makes no difference whether the organism consists of a single cell or a vast number.

UNICELLULAR ORGANISMS

Amoebae are single-celled organisms (see figure 1). In single-celled organisms, respiration takes place through the cell membrane. The surface area of the cell membrane is big enough to absorb enough oxygen and to release enough carbon dioxide. Single-celled animals therefore do not need special respiratory organs.

fig. 1 An amoeba (20× magnification).



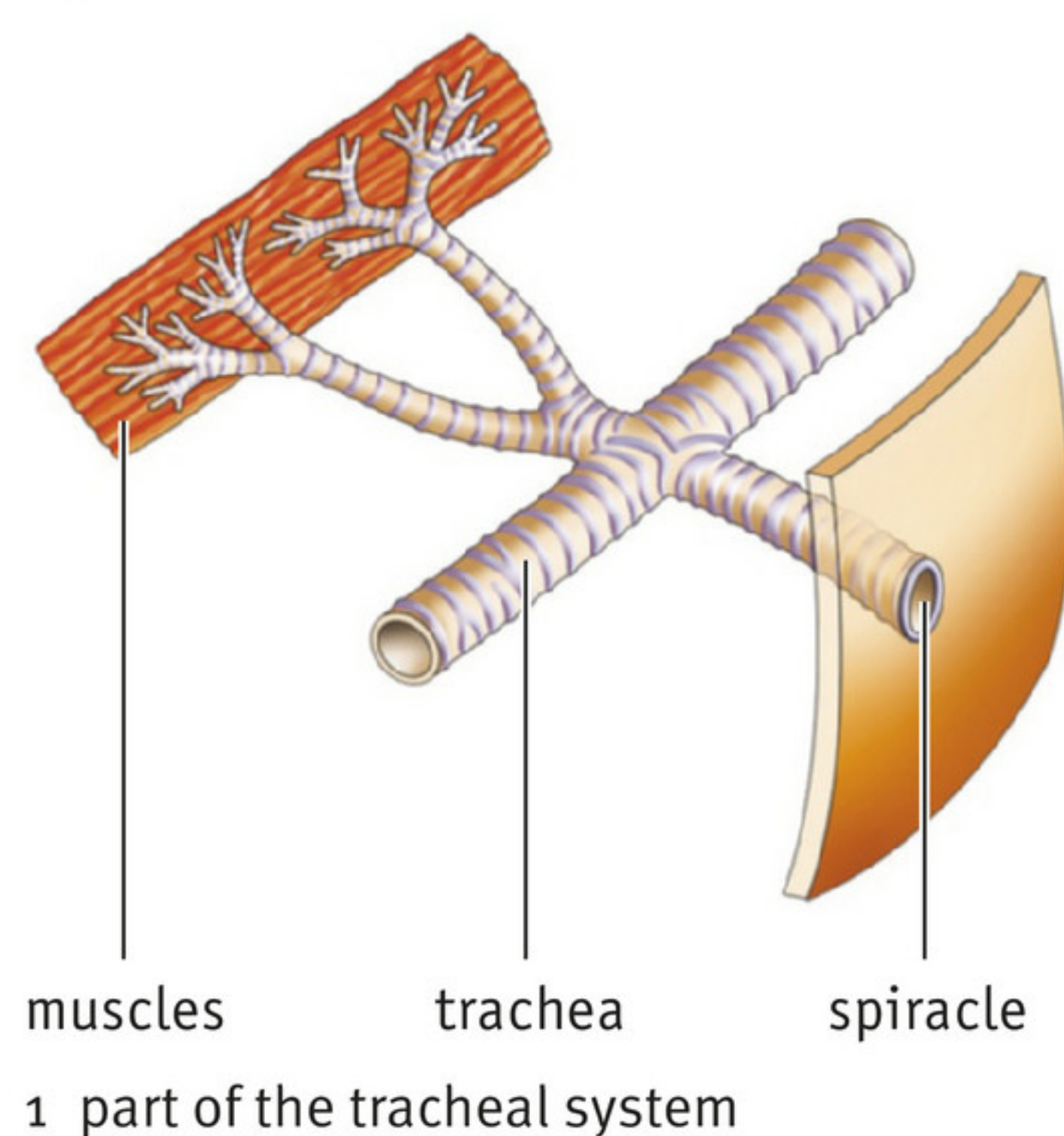
The surface area of multicellular animals (ones that are made up of large numbers of cells) is not big enough to absorb enough oxygen and to release enough carbon dioxide. On top of that, the skin of many animals is impermeable. All these animals need special respiratory organs that let them absorb oxygen and eliminate carbon dioxide. Examples of these organs are tracheae (in insects), gills (in fish) and lungs (for instance in mammals and birds).

INSECTS

Insects have tracheae. **Tracheae** are heavily branched tubes inside the body of the insect. There are openings that let air into the system of tracheae. These openings are called **spiracles** (see figure 2). The smaller branches of the tracheae end up everywhere in the body. Taken as a whole, all the branches have a large surface area, so that gas exchange can take place quickly.

In many species of insects, the spiracles are located largely in the abdomen. These insects make a kind of pumping movement with their abdomen, moving it back and forth so that the air in the tracheae is refreshed.

fig. 2 Spiracles.



FISH

Fish use **gills** to breathe. The gills are just behind the head, in the gill cavity (see figure 3). The gill cavities are covered by gill flaps. A gill consists of a gill arch on which there are a large number of gill lamellae (see figure 4).

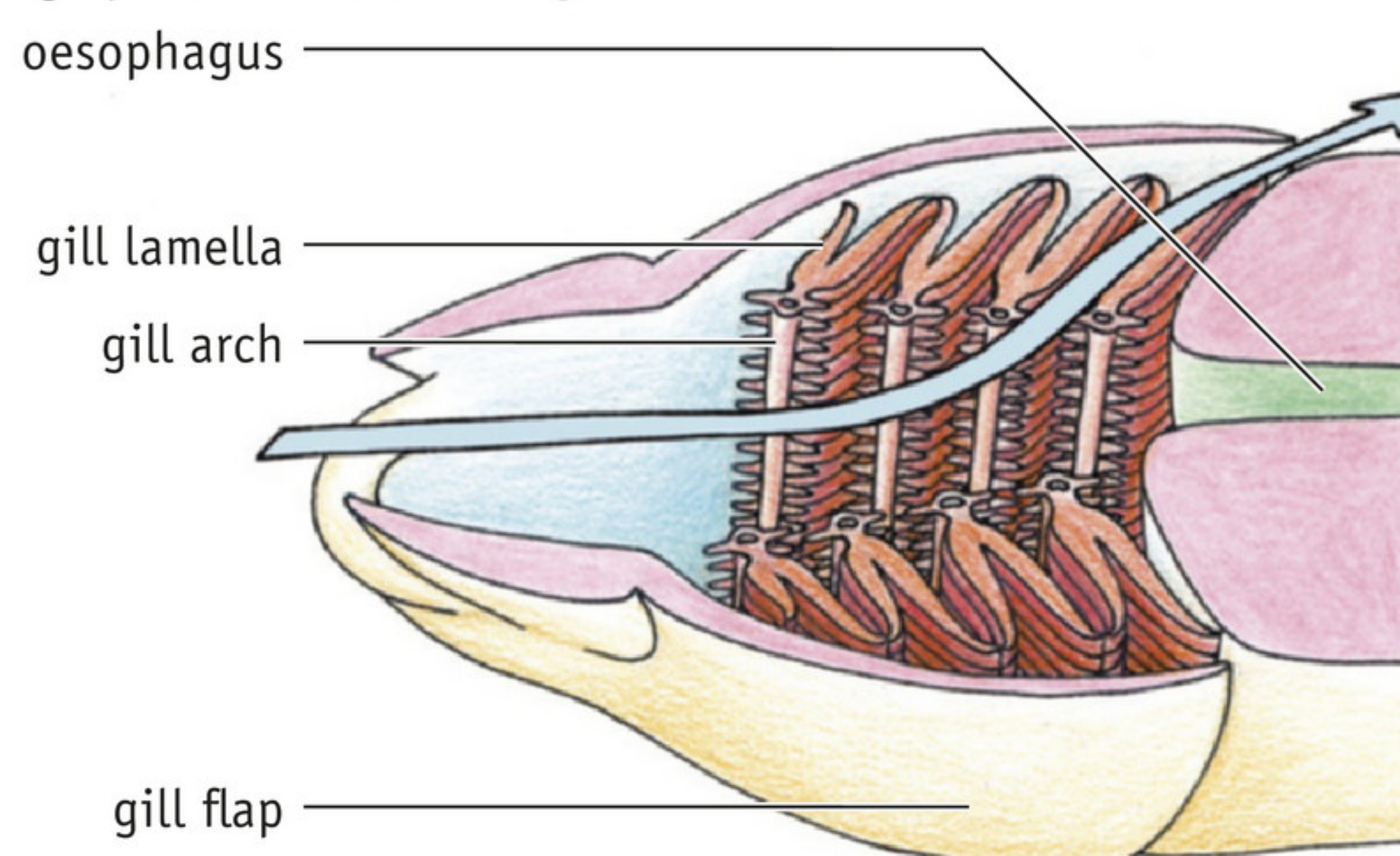
There are lots of thin blood vessels in the gill lamellae. The walls of the gill lamellae are very thin. Taken as a whole, the gill lamellae have a large surface area. That allows gas exchange to take place quickly. Oxygen is absorbed from the water into the blood and carbon dioxide is released from the blood into the water.

Humans breathe so that the air in their lungs can be refreshed. A fish and refreshes the water in the gills by opening and closing its mouth. That makes water flow past the gill lamellae. You can see that clearly in a fish in an aquarium. You will also be able to see the gill flaps opening and closing.

fig. 3 The gills of a fish.



fig. 4 The structure of gills.



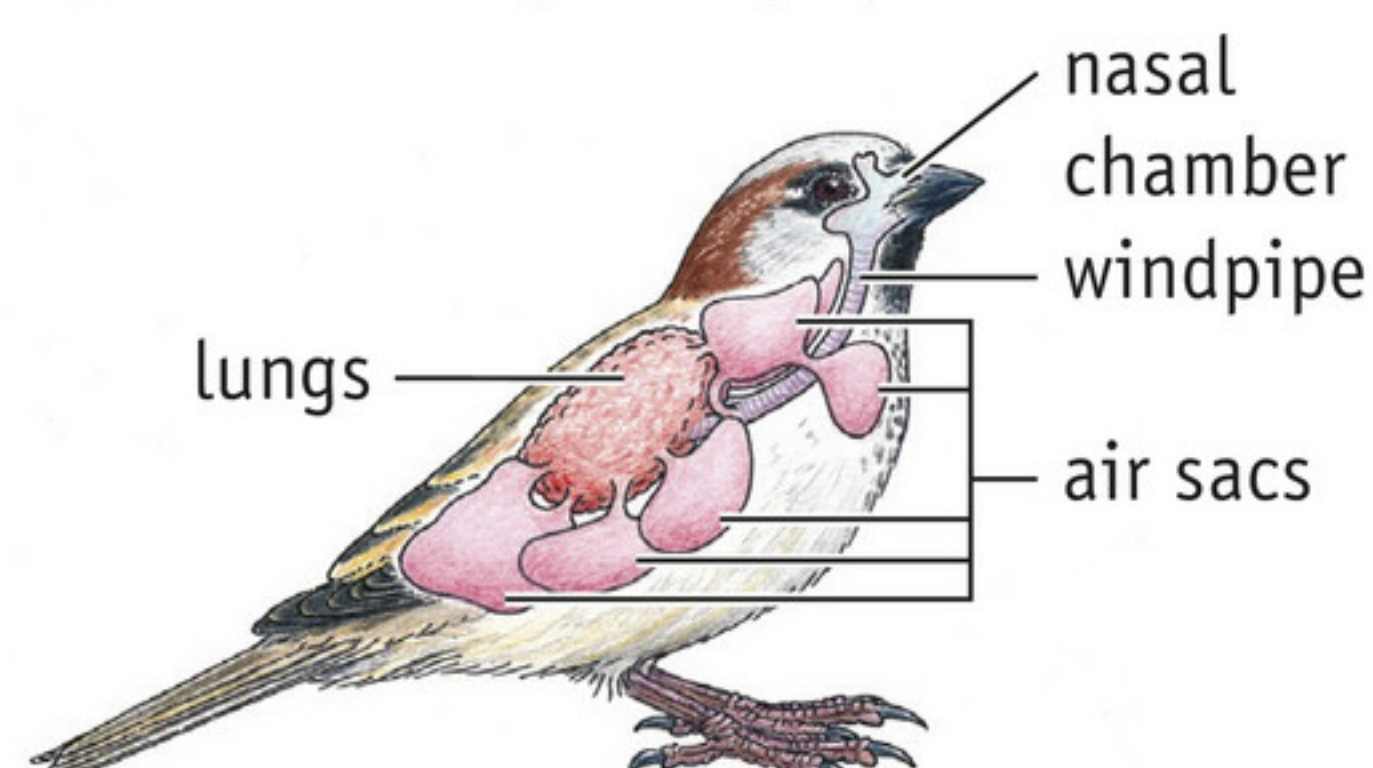
BIRDS

Birds' lungs work differently to the lungs of mammals (including humans). They have two nostrils at the top of the beak (see figure 5). Behind that is the nasal chamber, like your nasal cavity. Birds' lungs are smaller than the lungs of mammals and they do not have alveoli. There are **air sacs** fixed in place around the lungs (see figure 6). There are several air sacs at the front of the lungs (anterior), and more of them at the back (posterior).

fig. 5 A Falcon.



fig. 6 The respiratory system of a bird.

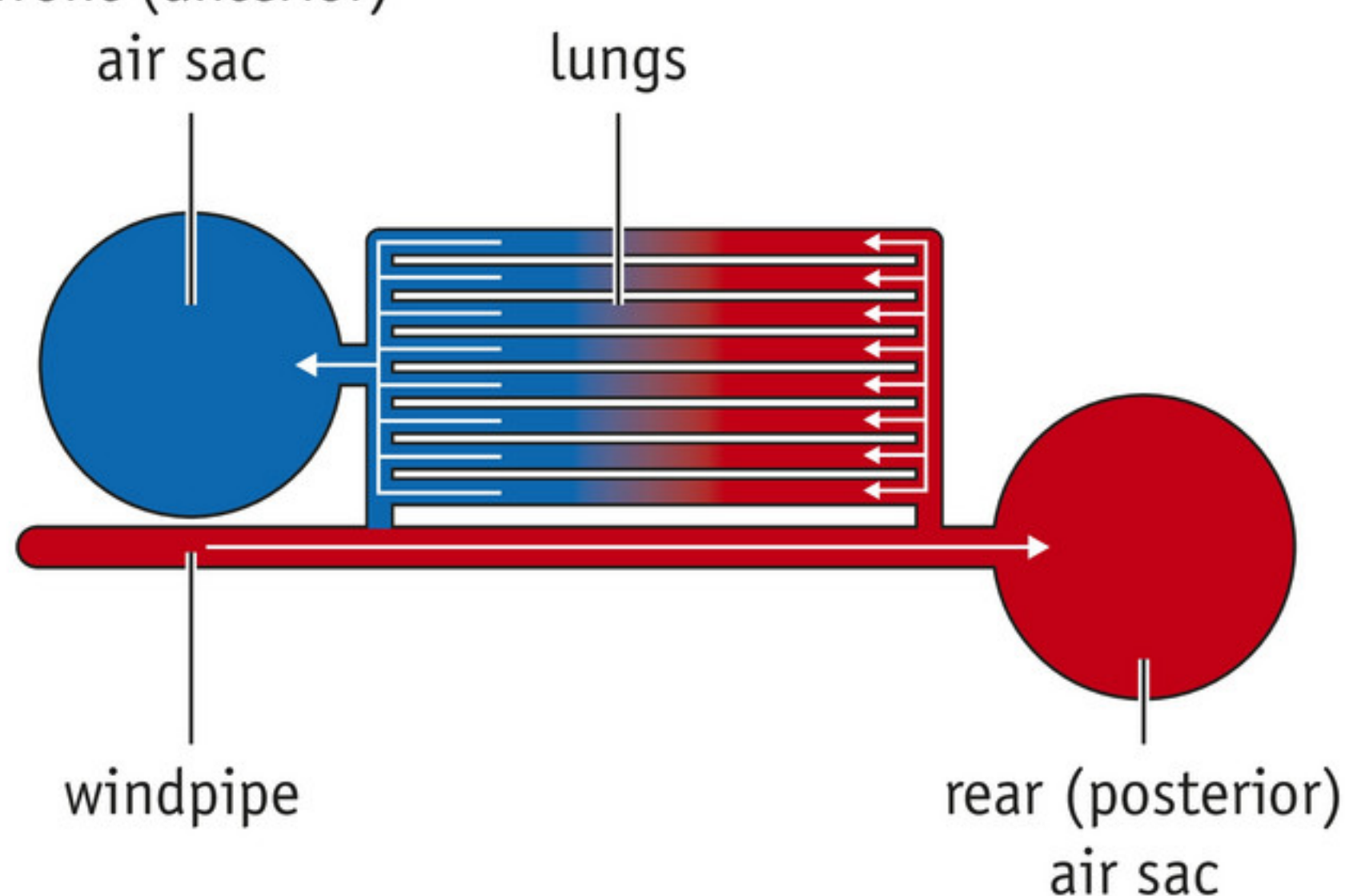


The bird's lungs do not get larger and smaller, but the air sacs around the lungs do. When a bird breathes in, all the air sacs get larger. Fresh air flows in through the windpipe into the air sacs at the back, while air flows through the lungs into the front air sacs (see figure 7.1).

During exhalation, air flows out of the front air sacs and out through the windpipe, while air then flows from the back air sacs into the lungs (see figure 7.2). This means that there is always oxygenated air flowing past the blood vessels in the lungs. So gas exchange occurs more quickly in birds than in mammals.

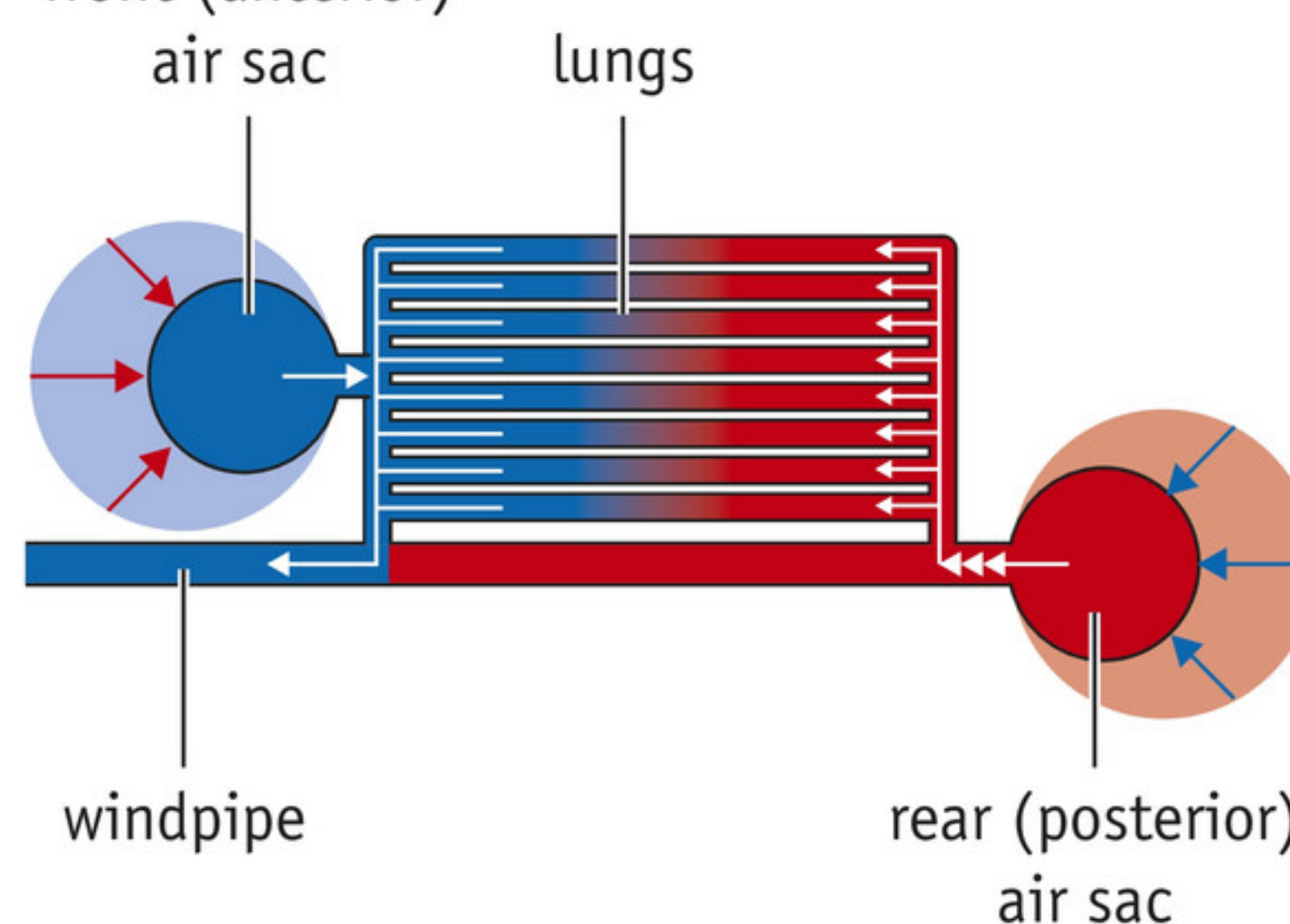
fig. 7 How birds' lungs work.

front (anterior)



1 the lungs of a bird after inhaling

front (anterior)



2 the lungs of a bird after exhaling

KNOWLEDGE

1

Different animals have a variety of respiratory organs.

a Write down the correct respiratory organ after each animal.

- blackbird
- grass snake
- red ant
- pike
- stickleback
- wasp

b Unicellular animals do not have special respiratory organs.

In unicellular animals, gas exchange takes place through the

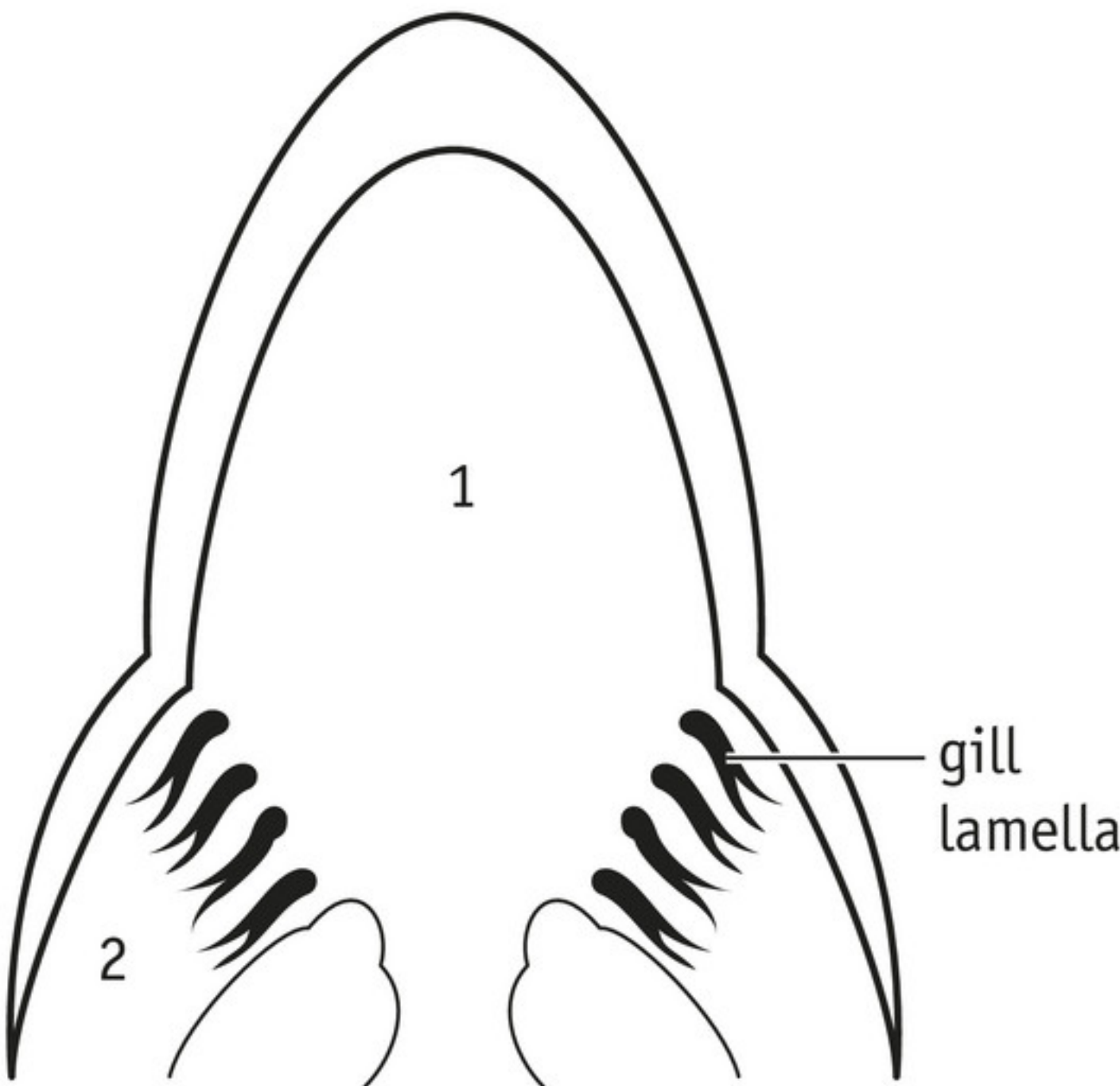
2

Figure 8 shows a schematic drawing of a fish’s head.

The water with the highest oxygen content can be found at number 1 / 2.

The water with the highest carbon dioxide content can be found at number 1 / 2.

fig. 8 Cross-section of the head of a fish.



3

a Which substances do the body cells of insects absorb from the air in the tracheae?

.....

b Write down two properties of tracheae that allow gas exchange to take place quickly.

4

Summary

Describe how gas exchange takes place in unicellular animals, fish and insects, and complete the table. When they have lungs, say how they work.

.....

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.....

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.....

Mammal	Bird
Lungs:	Lungs:
Air sacs:	Air sacs:
Gas exchange:	Gas exchange:

INSIGHT

5

In humans, the ribcage and abdomen move during breathing. Fish also need movements to let them breathe.

a Put the events in the correct order for a fish as it breathes.

- 1 The fish takes water into its mouth.
- The gill flaps close.
- The gill flaps open.
- The gill flaps are closed.
- The fish moves the bottom of its mouth up.
- The fish opens its mouth.
- Water flows into the mouth again.
- The water flows past the gills and out of the body.

b Figure 9 shows a great white shark. This species does not have gill flaps.
Explain why a great white shark always has to keep moving.

fig. 9 A great white shark does not have gill flaps.



6

Birds and mammals both breathe using lungs.

- a** Compare the direction that the air flows in through the lungs of the bird and a mammal. Describe inhalation and exhalation.
- b** In the lungs of mammals, the air flows in *one direction* / *two directions*. As a result, oxygen-rich and oxygen-depleted air *do* / *do not* mix.
In the lungs of birds, the air flows in *one direction* / *two directions*. Oxygen-rich and oxygen-depleted air *do* / *do not* mix in a bird's lungs.
Oxygen is absorbed more quickly into the blood in *birds* / *mammals*. That lets birds release *more* / *less* energy than mammals.

7

Figure 10 shows a mosquito larva. The larvae of mosquitoes live in water. They have a breathing tube at the back end of their body. The breathing tube is connected to the respiratory organs and reaches up to the water surface.

- a** What kind of respiratory organs do mosquito larvae have?
- ☐ A gills
 - ☐ B lungs
 - ☐ C tracheae
- b** Does a mosquito larva get its oxygen from the water or from the air? Explain your answer.
- c** Does a mosquito larva release carbon dioxide to the water or to the air? Explain your answer.

fig. 10 A mosquito larva at the water surface.



8

Mammals have a chest cavity and an abdominal cavity that are separate from each other. That is not the case in birds. The abdominal cavity of a bird is one large space.

- a What important respiratory muscle do birds therefore not have?
- b What is the normal form of breathing for birds?
 - ☐ A chest breathing
 - ☐ B abdominal breathing
 - ☐ C alternating chest breathing and abdominal breathing
 - ☐ D chest breathing and abdominal breathing at the same time
- c When you pick up a bird in your hands, explain why you must not hold the bird's body too tightly (see figure 11).

fig. 11 How to pick up a chick.



+ 9

A fish that is taken out of the water suffocates because its gills are not suitable for absorbing oxygen from the air. Explain why not.

HOW IT FITS TOGETHER the world we live in

SWALLOWS

Swallows do everything in the air: eating, drinking, sleeping and mating. They eat insects – thousands of them a day. Birds need a lot of energy. They have higher body temperatures than animals.

Swallows spend the winter in Africa but their breeding grounds include the Netherlands. A swallow returns to its old nest every year. Those are mostly hidden away in cracks in buildings, behind guttering and underneath broken roof tiles.

But they also use the old nests of sparrows and starlings. Each pair lays two or three eggs, which hatch after about three weeks. As they fly, the parents put the insects they catch into a throat pouch where they form a big ball. The throat pouch is part of the skin of the throat. The food that they store there is then fed to the young. There are not so many insects in cool summers and the parents will then fly to warmer areas such as the south of France and come back with food after several days.

fig. 12 A swallow.



10

Read the text 'Swallows'.

- a Does the metabolism (combustion) go faster, slower or at the same speed in a swallow as in a mammal of about the same size? Explain your answer.
- b When the parents are away for a long time looking for food, the young survive thanks to glucose that they have stored as a reserve in their bodies. The young are in a kind of 'rest mode' while they wait, with their metabolism slowed down. Explain why that means they can survive for longer.
- c Swallows live exclusively on insects. Nowadays, insects are always small but about two hundred million years ago there were much bigger insects. Fossils show that there were insects up to 60 cm in size. There was more oxygen in the air then than nowadays. Explain why that means insects are smaller now than two hundred million years ago.

 Go to the *Flash cards* and the *Test yourself* section.

How it fits together

FASHIONABLE FACEMASKS

We've only recently got used to them in the Netherlands too, but facemasks have already been a normal sight in the streets for a long time in Thailand (figure 1).

In Bangkok, the capital of Thailand, more than half of all people were already walking around with facemasks before the coronavirus pandemic. They were doing that for protection against the thick clouds of smog in the city. In February and March in particular, the air is full of smoke, dust and gases. On some days it gets so bad that the schools are closed and aircraft are not able to land.

fig. 1 Thai girls wearing facemasks.



SMOG

There are various causes of smog. First of all, there are more and more cars and buses on the streets. They cause more than half of the smog clouds. In and around the city, there will also be smoke from fires. Farmers use fires to get rid of the dead leaves on their sugar cane plantations. Other farmers set their rice fields alight after the harvest to help fertilize the land. And mushroom gatherers illegally set forest areas alight so that mushrooms and toadstools will then grow up above the soil. But the most poisonous vapours come from the huge maize plantations from the large companies producing animal feed. They spray pesticides on their crops, releasing toxins not only onto the plants but into the air.

A lot of people suffer from health problems because of the smog. People who used to be in good health get dryness in the nose, a dry cough, headaches and tightness around the chest. Young children, elderly people and those who already had problems with their airways can get inflammations of their bronchi. Lung cancer and heart problems occur more often in people who live in smoggy areas.

FILTER

Facemasks can help protect against smog. Smog is made up of particles smaller than sand grains. Particles that are smaller than 0.1 micrometre (μm) are classed as 'PM_{0.1}'. Particles of 0.1 to 2.5 μm are classed as 'PM_{2.5}' and particles between 2.5 and 10 μm are called 'PM₁₀' (10 μm is about a fifth of the thickness of a human hair).

Depending on how expensive and effective a facemask is, it will consist of several layers. A good facemask may have an initial layer that keeps out the PM₁₀ particles, a second that traps PM_{2.5} particles and a third one that stops the PM_{0.1} particles. When you are wearing a facemask, you are essentially sucking the air in through a filter. It is important that the facemask fits closely onto the face so that no air can pass around the edges. Smog does also occur in the Netherlands, for instance on hot days with not much wind. Fortunately, we are not often affected by severe smog. It seems likely that facemask fashion will all blow over in the Netherlands once the coronavirus pandemic is over.

EXERCISES

1

The hairs in your nose purify the air that you breathe in. They stop particles of 20 μm and larger.

- a** Do the hairs in your nose trap PM₁₀ particles?
- b** PM₁₀ particles stick to the nasal lining.
Describe the route that leads to those particles ending up in your intestines.
- c** People can get inflammation of the heart as a result of breathing smog in.
Can PM_{0.1} particles pass through the walls of the alveoli? Explain your answer.
- d** PM_{2.5} particles can get into the alveoli. They can then cover the surface of the alveoli.
What effect does that have on the uptake of oxygen?
- e** Compare the physical fitness of people who do wear facemasks and those who do not.
Explain why people who do not wear facemasks may be less physically fit after a few years.

2

If you wear a facemask, you are sucking the air in through a filter. Try breathing for a few minutes through a facemask or with your nose pinched closed a bit.

- a** What do you notice about your breathing?
- b** When you are wearing a facemask and breathing calmly, do you get as much oxygen in as when you are not wearing a facemask? Explain your answer.
- c** Which muscles do you use more intensively if you are breathing through a facemask?
- d** Many joggers in Bangkok wear facemasks. They can protect themselves against the smog that way, but some find that they can only run half their usual distances.
Why can joggers wearing a facemask not complete their circuit anymore?
- e** Do facemasks also filter out carbon dioxide? Explain your answer.

3

Some people live in areas where there is a lot of smog but never wear facemasks. They are used to the smog and say that it doesn't affect them much.

- a** What sensory organs let you detect smog?
- b** What happens to the signals going to your brain if you smell the toxic gases in smog every day?
- c** Is smog less dangerous for people who never wear a facemask? Explain your answer.
- d** A facemask can also help against hay fever.
Would a facemask that is a PM_{2.5} filter also keep out the pollen of a daisy (see figure 2)? *yes / no*
- e** Would you wear a facemask to reduce the symptoms of hay fever?

fig. 2 Daisy pollen (950 $\times$ magnification).



7

Smoking tobacco and cannabis

LEARNING OBJECTIVE

1.7.11 You know the potential consequences of addiction to tobacco and cannabis.

TAXONOMY	LEARNING OBJECTIVE AND EXERCISES
	1.7.11
Remembering	2c
Understanding	1, 2bd, 3a, 4a
Using	2a, 3b, 4b, 5
Analysing	4c

Information campaigns about smoking mean that everyone now knows that smoking is bad for your health. Nevertheless, about a quarter of the Dutch population still smoke.

TOBACCO SMOKE

People who smoke do not live as long as non-smokers. Smoking can give you cardiovascular and lung diseases. The two main lung diseases are lung cancer and COPD (*chronic obstructive pulmonary disease*), an incurable inflammation of the airways. The substances in smoke affect the senses of taste and smell. This means that smokers are less well able to taste and smell. Smoking also increases the risk of all kinds of other conditions, such as eye diseases, intestinal problems, dementia and rheumatism.

Nicotine is the substance in cigarettes that gets people addicted to smoking. The effects of nicotine are both psychological and physical. Nicotine has a stimulant effect: it increases the pulse rate and the blood pressure. This is why more smokers die of cardiovascular disease (heart conditions) than non-smokers.

The **tar** in tobacco smoke damages the insides of the airways. The cilia get damaged, making it more difficult for the mucus to be transported away. People who smoke cough a lot (a ‘smoker’s cough’) and they are more likely to get infections of the respiratory tract. The tar contains carcinogenic substances. Tar also causes the brown deposits on the fingers and teeth of smokers.

Carbon monoxide is an odourless gas. When you breathe carbon monoxide in, it is absorbed into the bloodstream. There is then less ‘room’ in your blood for oxygen. The body’s cells may then get too little oxygen.

fig. 1 This is what smoking does to your lungs.



The smokers are not the only ones who inhale the harmful substances. If you are in an environment where people are smoking, you inhale the smoke of the burning cigarettes and the smoke that is exhaled again by others. This is referred to as **passive smoking**. As a result, non-smokers can get the same diseases as smokers. To protect people against passive smoking, there is now no smoking in public spaces, on public transport, at work and in schools.

E-CIGARETTES, VAPE PENS AND HOOKAHS

Electronic cigarettes evaporate a liquid that contains nicotine and a flavouring. A vape pen is another form of electronic cigarette, using liquids that often no longer contain nicotine. A rechargeable cigarette looks like an e-cigarette but is actually a device for heating a stick of tobacco.

These forms of ‘electronic smoking’ also release harmful substances. The harmful substances in e-cigarettes include nicotine, metals and nitrogen compounds. Inhaling them can still damage the airways, cause heart palpitations and increase the risk of cancer.

Smoking using a hookah can lead to up to thirty times more carbon monoxide being released than smoking cigarettes. It can cause carbon monoxide poisoning; the symptoms are headaches, nausea, dizziness and fatigue. Lengthy exposure can result in loss of consciousness or even death because of a lack of oxygen in the brain.

WHY DO PEOPLE SMOKE, ACTUALLY?

Smoking is addictive. Even if you just smoke a cigarette occasionally, the need for nicotine soon takes hold. You will then want a cigarette more and more often: you have become **psychologically addicted**. Smokers also keep needing more and more nicotine to feel comfortable. This is called **habituation**. It then becomes more and more difficult to stop. You could say that the body starts protesting if you don’t smoke. These are called withdrawal symptoms. You have then become **physically dependent** – in other words, addicted.

In the previous century, people still often thought that smoking looked cool or hard or tough. Nowadays most people know how unhealthy addiction to smoking can be. That has changed the image of smoking. After all, smoking makes your breath and your hair and your clothes stink of smoke, it’s bad for your skin and it costs a lot of money. Why should you start?

Figure 3 gives some tips that will help you refuse cigarettes.

fig. 2 Simply don’t start.



fig. 3

This is how to say ‘No’.

Someone offers you a cigarette. You don’t want to hurt them and you don’t want an argument either. But you don’t want to get addicted – definitely not. So you say ‘No’.

Refuse

Say ‘No’ first and then give a reason. Say that you don’t smoke, for instance. “No, you know I don’t smoke.” Say it politely but clearly, and look at them. They may act disappointed, which is up to them – but don’t let them manipulate you!

Ignore

If someone keeps insisting, it’s perfectly alright to tell them that it’s annoying you. You can also ignore that person. Talk about something else. The message will get through after a while.

Leave

If that doesn’t help, you can always leave. If you don’t fancy smoking or standing in somebody else’s smoke, you can go somewhere else or walk away with somebody who is leaving.

After: Kun jij nee zeggen? (Can you say no?) Smoke Alert, Maastricht University and Stivoro.

CANNABIS

Cannabis products such as hashish and marijuana come from the hemp plant, *Cannabis sativa* (see figure 4). The psychoactive substance in cannabis (the substance that makes you stoned or high) is **THC** (tetrahydrocannabinol). THC is present in particular in the plant’s unfertilized female flower heads. There is no THC in industrial hemp, the plant that clothing fibres are made from.

There are about five hundred other substances in addition to THC in weed and pot. The most important one is **CBD** (cannabidiol). This substance does not have a psychoactive effect itself, but it does affect how THC works.

Cannabis is mostly smoked (a joint or in a pipe), eaten (space cakes, magic brownies) or inhaled after vaporization. Smoking a joint gets up to five times as much tar in the lungs as smoking a cigarette. It is therefore a very bad habit for the airways. Consumption of cannabis by road users is punishable by law.

EFFECTS OF CANNABIS

The short-term effects of cannabis depend on the type of pot or hash. Cannabis affects the consciousness. Some kinds make you **stoned** (lazy and relaxed), whereas others make you **high** (energetic and happy). The physical effects include a faster heart rate, lower blood pressure, headaches, dizziness, sleepiness, anxiety, poorer concentration and memory problems.

In the longer term, cannabis use leads to addiction, sleeplessness, sombre moods and concentration problems. Cannabis increases the risk of mental disorders such as depression and anxiety issues. If your DNA makeup makes you susceptible, it can cause schizophrenia. That is a severe psychiatric illness in which people lose touch with reality.

fig. 4 Cannabis flower heads (weed).



EXERCISES

1

Features of three of the components of tobacco smoke are given below.

a Connect the correct component or components to each feature.

- | | | |
|----------------------------------|-----------------------|---|
| A has no smell or taste | ☐ | ☐ 1 carbon monoxide |
| B is addictive | ☐ | ☐ 2 nicotine |
| C makes you less fit | ☐ | ☐ 3 tar |
| D reduces the transport of mucus | ☐ | |
| E causes cardiovascular diseases | ☐ | |
| F causes cancer | ☐ | |

b When someone who doesn't smoke lights up a cigarette, the first thing they notice is that they feel dizzy.

What component in the smoke causes this? Explain your answer.

c Smokers have a greater risk of getting certain diseases.

Write down three of these diseases.

2

There are many families where one or both parents smoke. Children of parents who smoke are more likely to become smokers than children of parents who do not smoke.

a Think of two reasons for this.

b Are the children of parents who smoke more likely to get lung cancer than children of parents who do not smoke? Explain your answer.

c What do you call it when someone inhales tobacco smoke that has been exhaled by someone else?

d Name a measure that protects non-smokers from passive smoking.

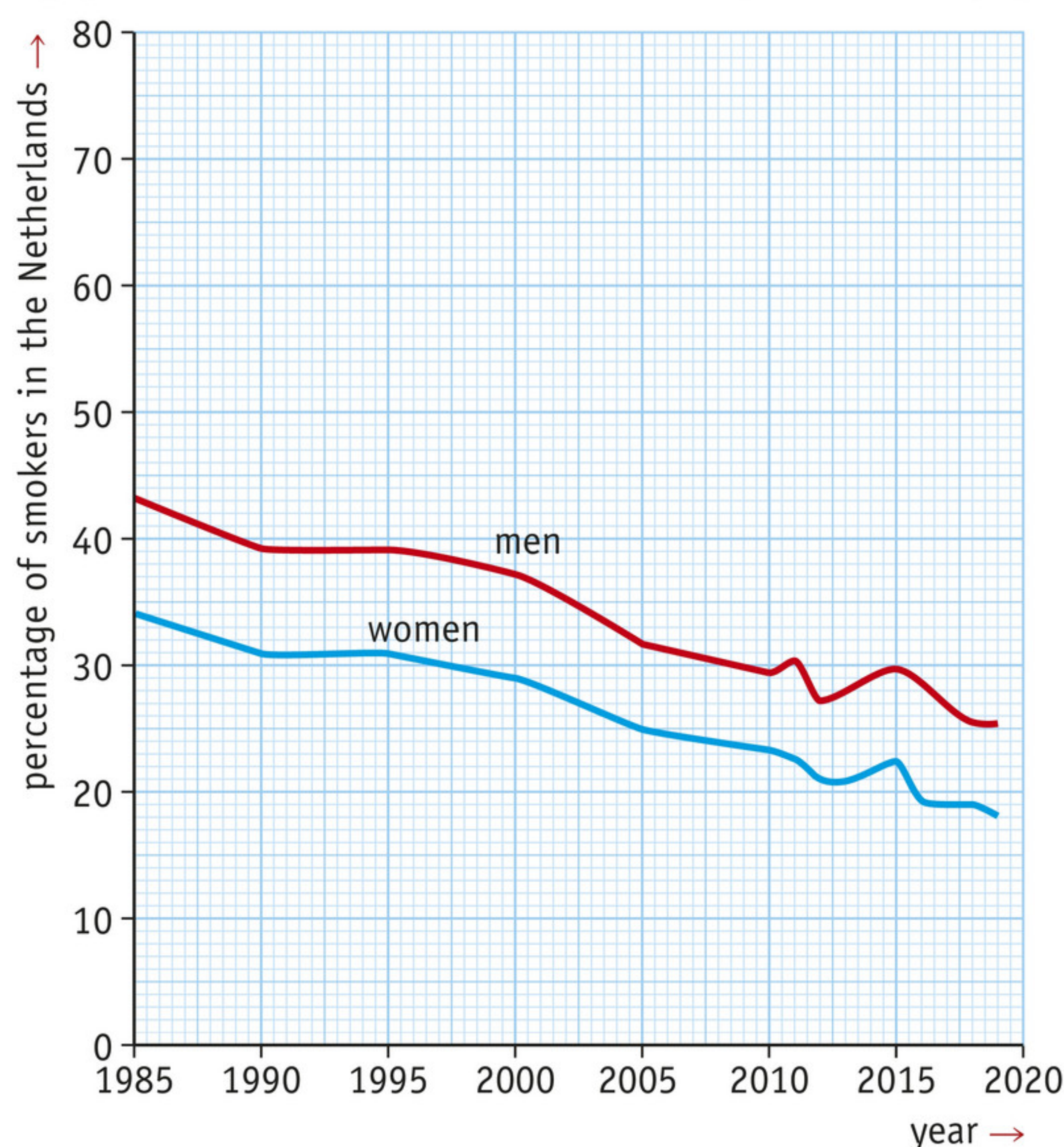
3

The diagram in figure 5 shows the percentage of smokers in the Dutch population. The diagram shows it for the period 1985-2019.

a What percentage of Dutch men smoked in 2019? And what percentage of Dutch women?

b What was the percentage decrease in the number of male smokers since 1985?

fig. 5 Smokers in the Netherlands in the period from 1985 to 2019.



Source: Health/Lifestyle Monitor, Statistics Netherlands in cooperation with the National Institute for Public Health and the Environment (RIVM) and the Trimbos Institute

4

- a Explain why cannabis is bad for your performance at school and at work.
- b Given the effects of cannabis, explain why people with heart problems should not use cannabis.
- c Abdul says that if you use cannabis a lot, you may start to see things that aren't there and that you can suddenly be afraid that you are being followed even though nothing is wrong.
Is he right? Explain your answer.

5

Read the text 'Ewan (17) has been smoking cannabis for two years now' in figure 6. Form a group of up to four pupils and make a presentation (for example using PowerPoint or Prezi) about using cannabis. Use figure 6 and look for information on the Internet. The presentation should at least cover the following aspects:

- the reasons why people use cannabis
- the problems caused by using cannabis
- what you can do to tackle problems with cannabis

fig. 6

Ewan (17) has been smoking cannabis for two years now.

"I get so bored when I come home in the evening. Smoking pot [cannabis] helps me cope with the boredom. I don't feel so sad then. My parents keep on whingeing at me. They are worried. I see less and less of my friends and relatives.

I don't hang out with my old friends; I've got new friends instead who also like a joint. Smoking grass [cannabis] is expensive. Since I've started smoking pot every day, I can't concentrate so well and I don't get anything done anymore. I often feel listless and depressed. Things are going badly at school. I'm often late."

Source: www.cannabisdebaas.nl.



 Go to the *Flash cards*.

8 Cold-blooded and warm-blooded

LEARNING OBJECTIVE

1.8.12 You can describe the difference in cellular respiration between cold-blooded and warm-blooded animals.

TAXONOMY	LEARNING OBJECTIVE AND EXERCISES
	1.8.12
Remembering	
Understanding	3a
Using	1, 2a, 4abc
Analysing	2b, 3b, 4d

The combustion of glucose inside your body releases energy. You use that energy to move and to stay warm. Some animals do things differently.

COLD-BLOODED

Some animals keep their body temperature up at all times (constant). These are called **warm-blooded**. Other animals have varying body temperatures that are the roughly same as the temperature of the surroundings. They are called **cold-blooded**. Only birds and mammals are warm-blooded.

Respiration in cells depends on the temperature. The higher the body temperature, the more combustion takes place. If the temperature of the surroundings is low, the body temperatures of cold-blooded animals are also low. Not much combustion is then taking place in their bodies. If respiration (combustion) is slow, there is not much energy available. This is why cold-blooded animals are not very active in cold weather.

Many cold-blooded animals **hibernate** during the winter. Tortoises, for instance, find a sheltered place where they can hibernate and dig themselves in (see figure 1). During hibernation, the animal’s body temperature drops and their metabolism slows right down. That means that they use very little energy and need very little oxygen. Some reptiles can go through a complete hibernation without breathing at all.

fig. 1 A hibernating tortoise.



WARM-BLOODED

Birds and animals have a constant body temperature. This makes them less dependent on the temperature of the surroundings. Their bodies have high respiration rates: combustion is taking place continuously. This releases a lot of energy. As a result, many birds and mammals are also able to keep an active lifestyle during the winter.

In the winter, extra energy is needed to maintain their body temperature, which means they need a lot of food. The animals have to move around a lot to find that food, and that needs energy as well and therefore even more food.

Warm-blooded animals need **insulation** to make it easier to keep their body temperatures constant. Mammals have a layer of fat under the skin and a thick coat of fur. Birds also have a layer of fat under the skin and a thick coat of feathers. Many birds also go away in the autumn, leaving for warmer climates. That is called **migration**. Some mammals migrate as well. Grey whales migrate to warmer waters in the autumn, for instance. Some mammals also hibernate, such as hedgehogs and bats for example.

EXERCISES

1

Why is it that birds and mammals are virtually the only animals living in the polar regions for most of the year?

2

Read the text 'Marine iguanas' in figure 2.

- a Marine iguanas are *cold-blooded* / *warm-blooded*.
- b Explain the advantage to marine iguanas of warming up in the sun first before they go in search of food.

fig. 2

Marine iguanas

Marine iguanas live on the Galapagos islands. Like most reptiles, they often lie in the sun to warm up. Once they are sufficiently warm, they dive into the water and go looking for food. Marine iguanas graze on the algae on rocks at the bottom of the sea. They often can't do this for more than an hour because of the cold water. They come back up and find a spot on the warm rocks.



3

Read the text 'Bats are protected' in figure 3.

- a What happens to the body temperature of bats that are woken up during hibernation? The body temperature *increases* / *decreases*.
- b Explain why bats that are disturbed several times during hibernation are more at risk of dying during a long winter than bats that are not woken up.

fig. 3

Bats are protected

Because of their habit of roosting together in large groups, bats are very vulnerable. If their rest is disturbed, an entire colony can be decimated. There are not many hollow trees, which bats like to rest in during daylight. Bats hibernate in places where there is very little disruption and the temperature does not drop below freezing. There are not many places like that either. During hibernation, bats live from the food reserves they have stored in their bodies.

In Limburg, several bunkers from the Second World War have been set up as places where bats can stay through the winter. But because the padlocks on the door were regularly vandalized, the bats could easily be disturbed. Now the doors have been welded shut to prevent vandalism and ensure that the bats are left in peace, so that more of them will survive the winter.

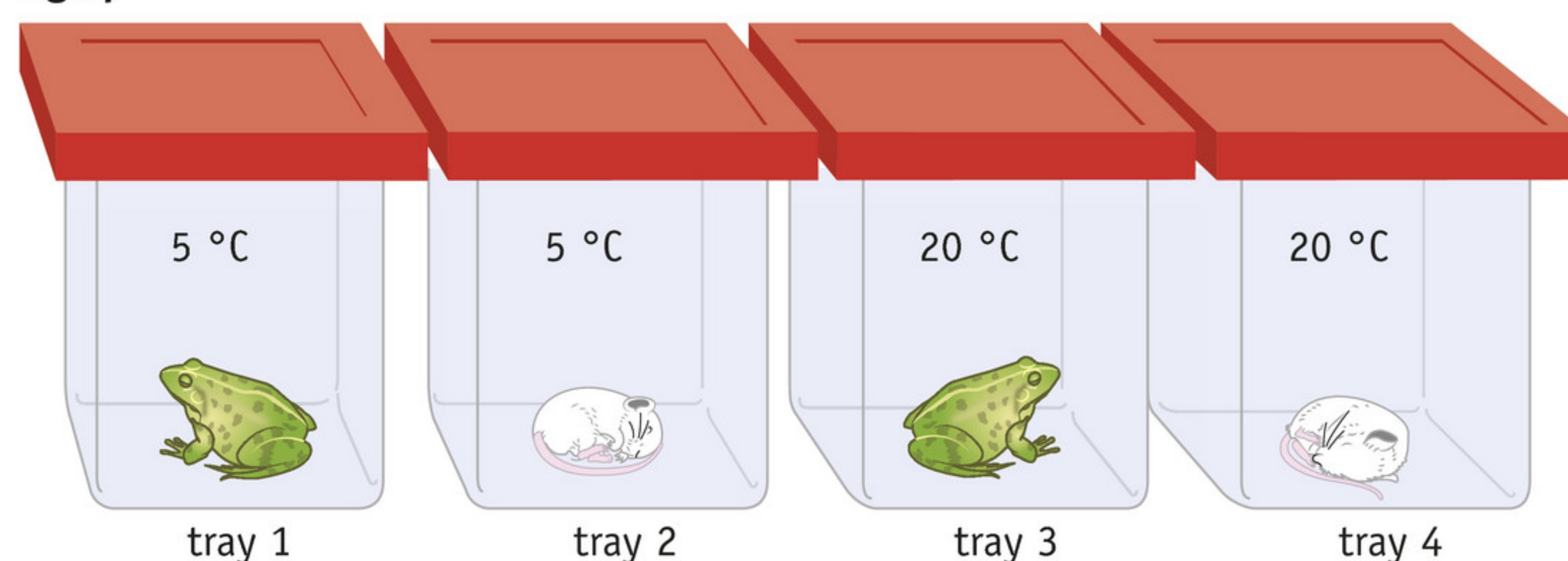


4

Two frogs and two mice have been drawn in figure 4, each sleeping in a closed container. The four animals are all the same size. The temperature in the containers is different.

- Compare the frog in container 1 with the frog in container 3.
Which frog has the higher body temperature?
the frog in container 1 / 3
Which frog will have more respiration going on in its body?
the frog in container 1 / 3
- Compare the frog in container 3 with the mouse in container 4.
Which animal has the higher body temperature?
the frog in container 3 / the mouse in container 4
Which animal will have more combustion going on in its body?
the frog in container 3 / the mouse in container 4
- Compare the mouse in container 2 with the mouse in container 4.
Is there a difference in body temperature between the two mice? yes / no
Which mouse will have more respiration going on in its body?
the mouse in container 2 / 4
- In which of the four containers will the oxygen level be decreasing fastest? Explain your answer.

fig. 4



Go to the *Flash cards*.

Learning how to do research

1

DISCUSSION

► Basics 2 | ► Learning objectives 1.O.13 and 1.O.14

THE STEPS IN RESEARCH: RECAP

Table 1 is a recap of the first six steps of a scientific study.

Table 1 Steps in scientific research.

Step in the research	Description
1 Study question	The question that you want to find the answer to.
2 Hypothesis	A possible answer to the study question.
3 Work plan	A step-by-step plan that describes what you are going to do to test the hypothesis, including a list of what you will need.
4 Doing the experiment	Collecting together the things you need and carrying out the work plan.
5 Results	Examining the results, processing them into one or more tables and/or diagrams.
6 Conclusion	The answer to the study question.

STEP 7: DISCUSSION

The final step in a scientific study is the **discussion**. You do two things in this step. First, you compare your conclusion against the hypothesis to see if the hypothesis has been confirmed. Then you look critically at your research. You do that to let you decide how confident you are in your results.

If the conclusion agrees with the hypothesis, you can say that the hypothesis has been **confirmed**.

If the conclusion is not the same as the hypothesis, you can say that the hypothesis has been **rejected**. That means that the hypothesis was incorrect. You then think up a new study so that you can find the answer to the study question after all.

If the hypothesis was rejected, you try to find an explanation why. That means looking critically at your research. You see if everything went according to the work plan, whether you did the work accurately and whether the work plan itself was in order. That lets you judge how reliable the results are. You try to find explanations as far as possible about why the hypothesis was not confirmed.

Even if the hypothesis was confirmed, you still take a critical look at your research. In scientific research, it is important to be sure that the results are reliable.

EXERCISES

1

Some scientific research does not have a hypothesis.
Why is it then still useful to carry out the discussion step?

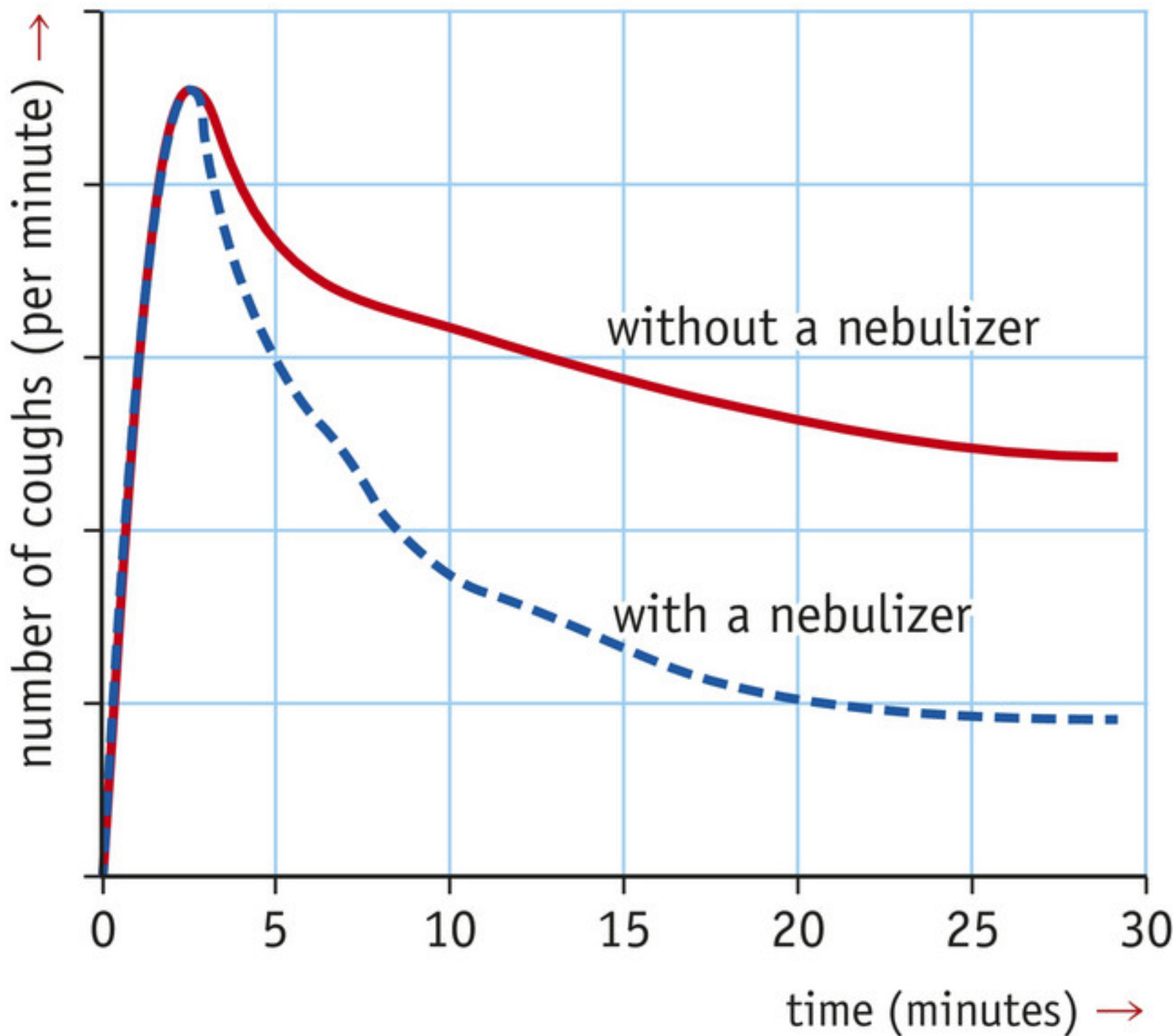
2

Many speed skaters get an annoying cough after skating the 1500 metres. This is known as the 1500-metre cough. The 1500-metre cough is caused by skaters breathing deeply through their mouths during the 1500 metres race. The cold dry air irritates the lining in the respiratory tract.

Figure 1 shows an experiment that was done about reducing these symptoms.

- a Write down the conclusion for this study in the table.
- b Does the hypothesis match your conclusion? *yes / no*
- c Why can't you judge how reliable the results are?

fig. 1

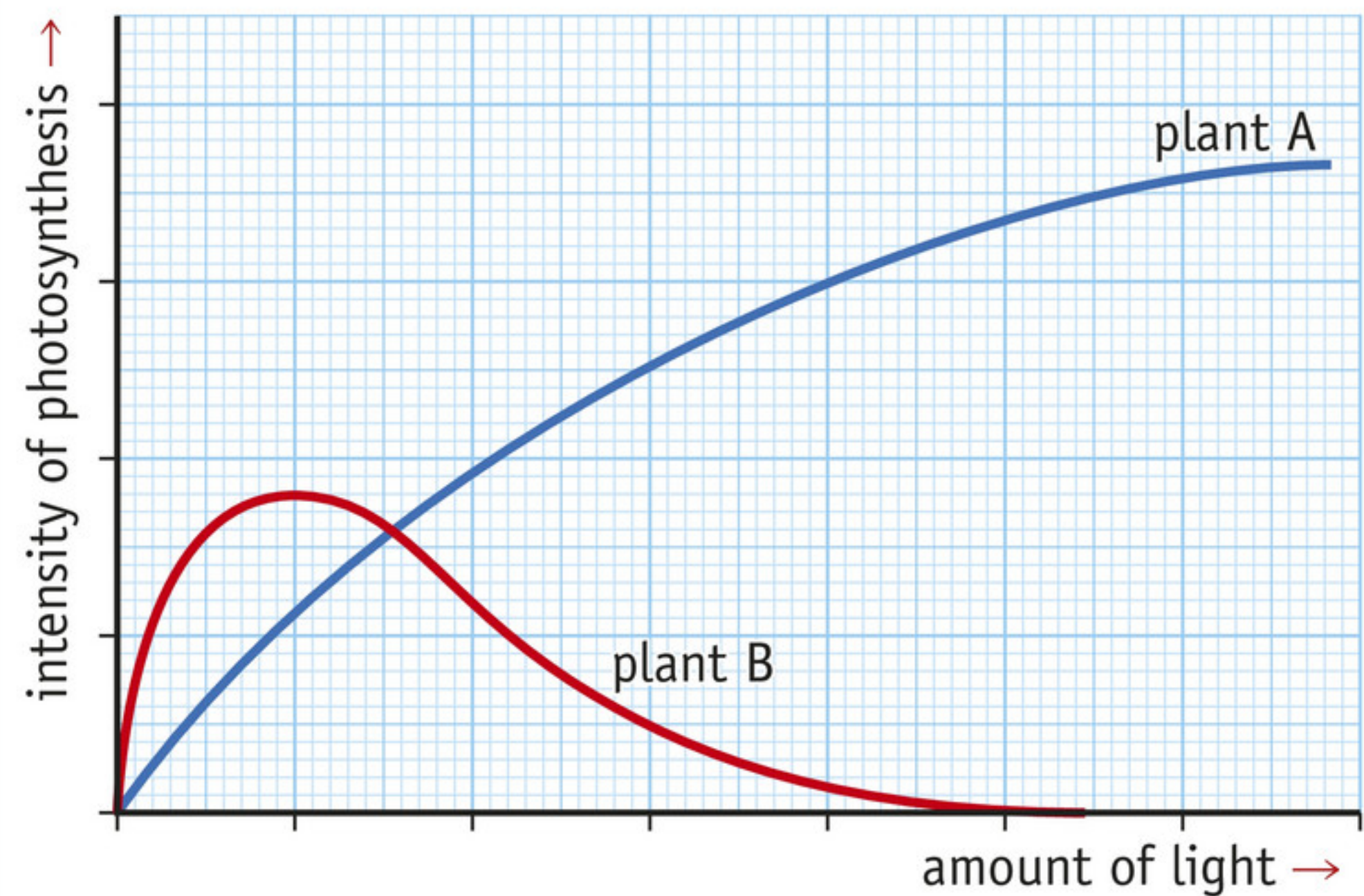
STUDY	1500-METRE COUGH
Study question	What can be done to reduce the problems after skating the 1500 metres?
Hypothesis	There will be less of a problem with coughing if skaters inhale moistened air after skating the 1500 metres.
Working method	A group of sixteen experienced speed skaters took part in an official race over 1500 metres. Immediately after the race, half the group was given a spray that moistens the lungs more. The other half of the group did not get it. The skaters' coughing was then measured during the first thirty minutes after the race ended.
Results	The measurement results are shown in the diagram.
Conclusion	

3

Figure 2 shows an experiment in which the effect of light on the intensity of photosynthesis in two different plants is investigated: sun-loving plants and shade-loving plants. The intensity of photosynthesis is a measure of how fast plants are growing. Read the study question in figure 2.

- a Think up a hypothesis and write it down in the table. Give a brief explanation with your hypothesis.
- b Read the rest of the details of the research in figure 2.
What conclusion can you draw from this study? Write it down in the table.
- c Are there any differences between your hypothesis and your conclusion? If so, what are they?
- d Does your hypothesis fit with your conclusion? *yes / no*
So the hypothesis was *confirmed / rejected*.

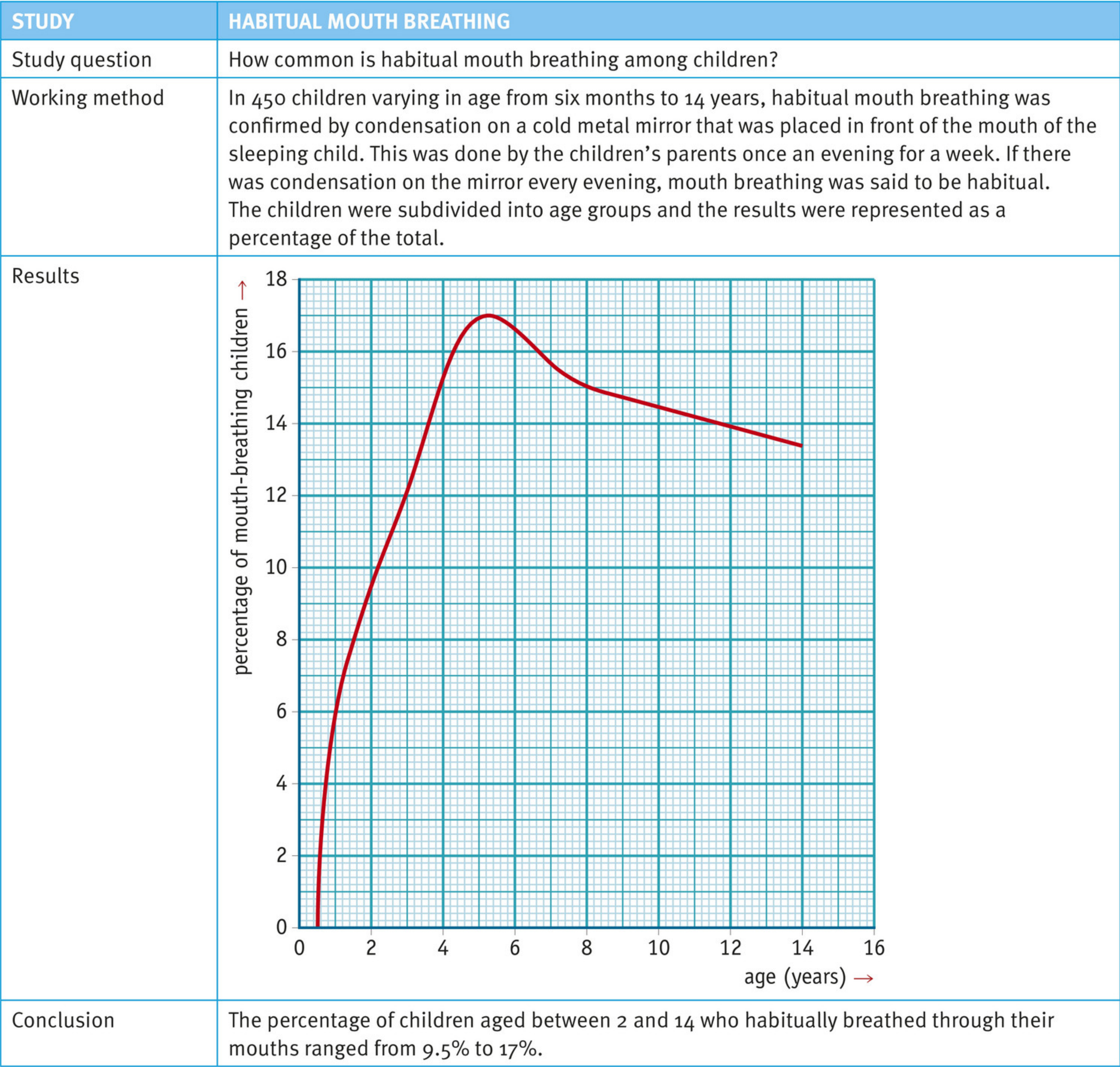
fig. 2

STUDY	THE EFFECT OF LIGHT ON THE INTENSITY OF PHOTOSYNTHESIS
Study question	Does the intensity of photosynthesis always increase for all plants as the amount of light increases?
Hypothesis	
Working method	The intensity of photosynthesis was measured in a group of sun-loving plants at various light levels. This was then repeated with a comparable group of shade-loving plants. The measured data has been displayed as a graph.
Results	
Conclusion	

4

When your nose is blocked, you sometimes have to breathe through the mouth. Some people however do that all the time. This is called habitual mouth breathing. Research has shown that children who habitually breathe through their mouths get infections of the airways more often than children who breathe through the nose. Researchers therefore want to find out how often habitual breathing through the mouth occurs in children. Figure 3 shows you how this study was carried out. After carrying out the study, it turned out that some parents did not hold a mirror up in front of the sleeping child’s mouth every evening because they forgot to do it. What can you say about how reliable the study is? Make a judgement about the work plan and the way it was carried out.

fig. 3



5

Read the text 'Asthma on the roller-coaster' in figure 4.

- a** What is the conclusion of this study?
- b** A total of forty students took part in the study: twenty-five who have asthma and fifteen who do not.
What would be two ways of improving the work plan to make the results more reliable?

fig. 4

Asthma on the rollercoaster

In 2010, the Dutch researchers Simon Rietveld and Ilja van Beest won a prize for a piece of research that first makes you laugh and then gets you thinking. They were investigating the effect of 'healthy excitement' on asthma. Healthy excitement is for instance the tension that a child feels before their birthday. According to the researchers, this is the same kind of tension that you experience before a ride on a rollercoaster. Healthy excitement can make people forget that they have asthma.

To investigate this, they got twenty-five students with asthma and fifteen who do not suffer from asthma to take a ride on a rollercoaster. Before the ride, the students were a little bit nervous. The ones who had asthma complained that they were a bit short of breath. Their nervousness was apparent for instance from their elevated heart rate, but they had no symptoms of an asthma attack. After the ride on the rollercoaster, the students were happy and were enjoying themselves a lot. The ones who had asthma were now no longer complaining about shortness of breath, although their lung function did turn out to be reduced. The ride on the rollercoaster caused asthma attacks, but the students hadn't noticed it. According to the researchers, people with asthma may unconsciously think that they cannot have asthma attacks if they are feeling good, because they feel unwell during asthma attacks. The converse could then also be true. If they are not feeling good, this could be because they are having an asthma attack and therefore they feel short of breath.



2

AIR

► Basics 2 | ► Learning goals 1.O.15 and 1.O.16 | ► Practical activities 1, 2, 3, 4 and 5

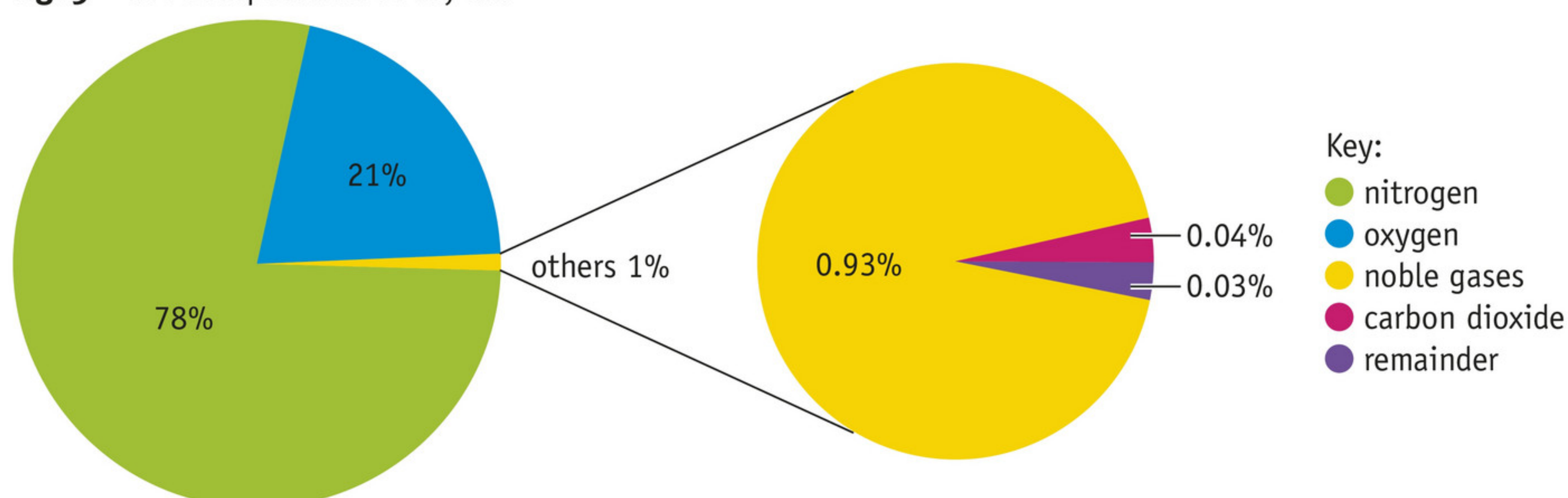
THE COMPOSITION OF AIR

Air is a mixture of several different gases. You cannot see the gases in air.

Air consists largely of nitrogen and oxygen, plus inert gases and just a little carbon dioxide. Air also always contains water vapour, although the quantity of water varies. The composition is therefore often stated for dry air.

Figure 5 shows you the gases that are present in dry air.

fig. 5 The composition of dry air.



You breathe air in and out again. The composition of the air that you breathe out (exhale) is not the same as the air you breathe in (inhale): respiration has happened. The combustion in respiration produces water and carbon dioxide. You can sometimes see water, for example as the condensation on a cold glass. You cannot see carbon dioxide, but you can use a detection test to show that it is there.

AN INDICATOR

There is carbon dioxide in soft drinks or sparkling mineral water. Those are the bubbles that you can see (the fizz). If you pour mineral water into clear limewater, the limewater goes cloudy (see figure 6). That is because of the carbon dioxide in the mineral water. So clear limewater lets you show if carbon dioxide is present. A substance that can be used to demonstrate the presence of another is called an **indicator**. Every substance has its own indicator.

fig. 6 Limewater.



1 clear limewater

2 cloudy limewater

3

VITAL CAPACITY

► Basics 5 | ► Learning Goal 1.O.17 | ► Practical activity 8

TIDAL VOLUME

Not everyone's lungs are the same size. The volume of the lungs is less for children than for adults. The amount of air inhaled and exhaled with each breath varies too.

When an adult is breathing normally, about 0.5 litres is inhaled and exhaled with each breath. That amount of air is called the **tidal volume**. About 150 mL of air gets no further than the bronchi, the trachea, the throat and the nasal cavity. This is the **dead space**. The air in the dead space is not involved in the gas exchange in the alveoli. This air is expelled during the next inhalation without having been used.

VITAL CAPACITY AND LUNG VOLUME

By breathing in very deeply, an adult can on average inhale about an extra 3 litres of air. By exhaling fully, they can on average expel about another 1.5 litres of air. The maximum amount of air that can be breathed in or out per breath is known as the **vital capacity**.

You can determine the vital capacity by:

- first breathing in as deeply as possible
- and then measuring the amount of air exhaled when you breathe out as fully as possible.

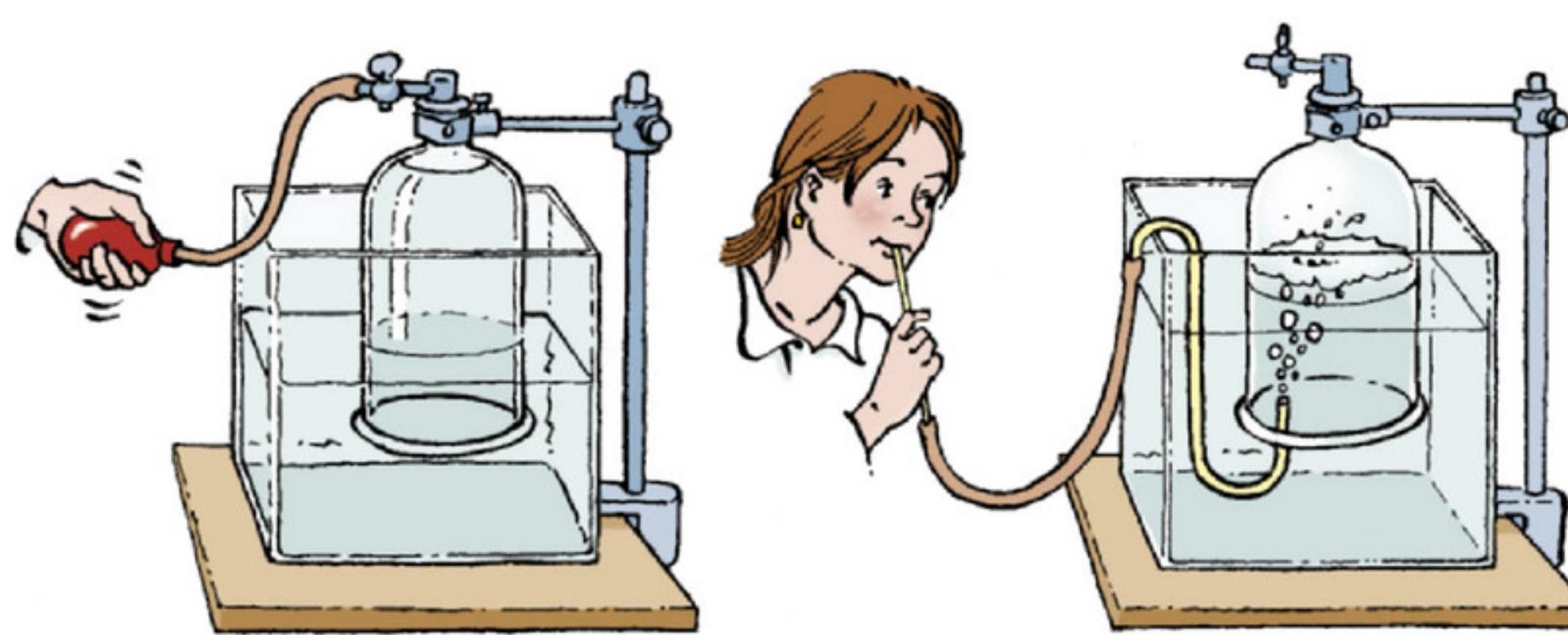
Some air always remains in the lungs. After exhaling deeply, an adult will on average still have about 1.5 litres of air left in the lungs and the airways. This is known as the **residual volume**. The vital capacity plus the residual volume makes the **lung volume**.

You can measure the vital capacity using a spirometer (see figure 7). You can also measure the vital capacity using a computer or using the experimental setup shown in figure 8.

fig. 7 Measuring the vital capacity with a spirometer.



fig. 8 Experimental setup for measuring the vital capacity.



1 sucking air out of the bell jar 2 exhaling into the bell jar

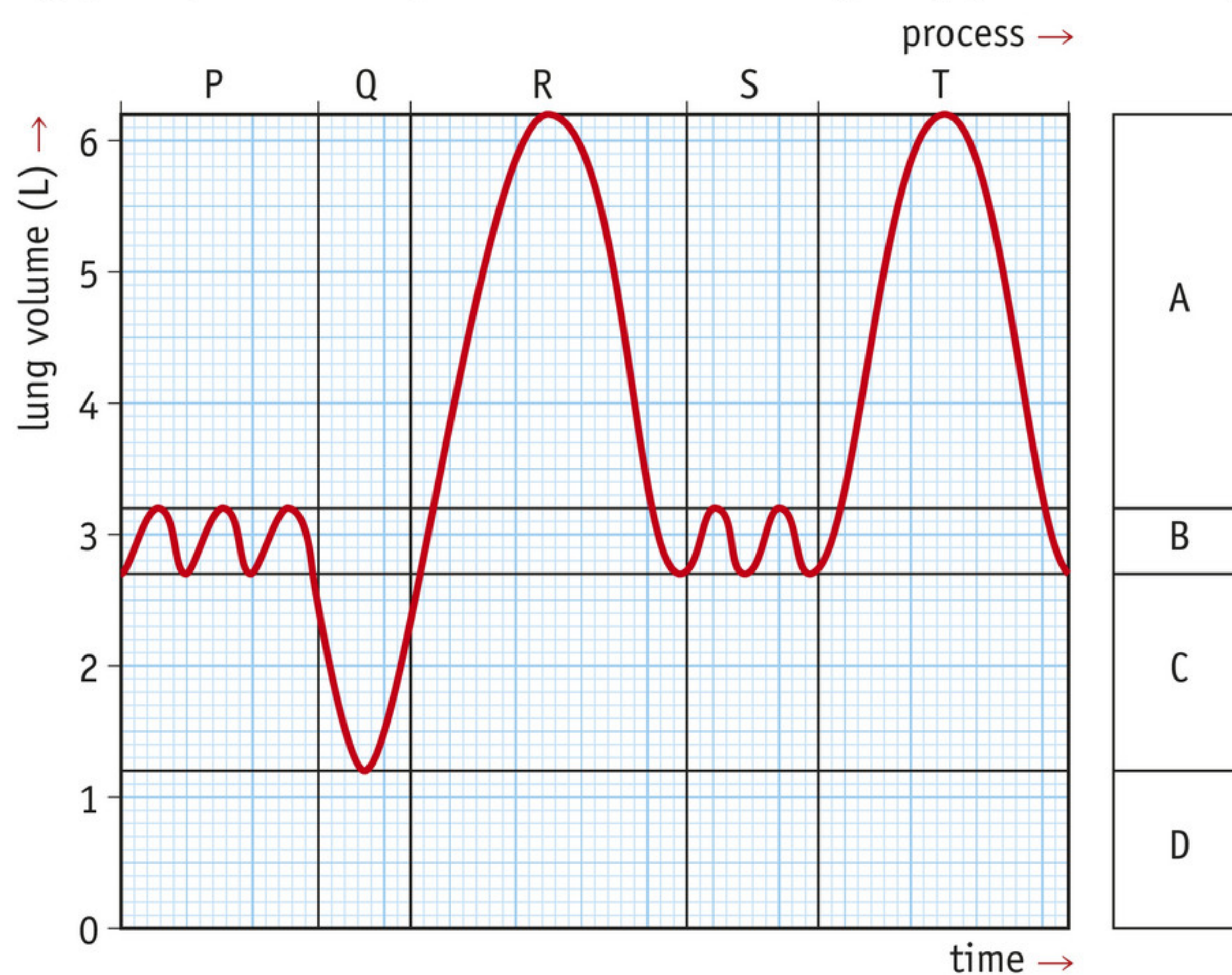
EXERCISES

1

Figure 9 is a diagram of a person's lung volume. Intervals P, Q, R, S and T are shown in the diagram.

- During which interval (or intervals) did the person inhale very deeply?
in period *P / Q / R / S / T*
- During which intervals did the person exhale very deeply?
in period *P / Q / R / S / T*
- Sections A, B, C and D are shown next to the diagram.
Which section gives the tidal volume?
section *A / B / C / D*
- How many extra litres of air can this person inhale when breathing in deeply? L
- What is this person's vital capacity? L
- What proportion of the air in the lungs is represented by section D?
☐ A tidal volume
☐ B dead space
☐ C lung volume
☐ D residual volume
☐ E vital capacity

fig. 9 A person's lung volume when breathing deeply and shallowly.



2

You can use a snorkel to breathe under water (see figure 10).
What is the disadvantage of a long snorkel? Think about the lung volume.

fig. 10 Snorkelling.



Practical activities

1 COMBUSTION IN A CANDLE

► Basics 2 | ► Learning objectives 1.2.4 and 1.O.13 | ► Learning how to do research 1 and 2

 25-30 minutes

WHAT ARE YOU GOING TO DO?

If you seal off a burning candle from the air, you will see changes. In this practical activity, you will be investigating what those changes are.

WHAT DO YOU NEED?

The things you need are given in the table.

WORKING METHOD

Do the experiment and complete the rest of the table.

STUDY	COMBUSTION IN A CANDLE
Study question	What is produced when a candle burns?
Hypothesis	
What do you need?	☐ a candle end ☐ a saucer ☐ matches ☐ a jam jar
Working method	- Put the candle end on the saucer and light the candle. - Place the jam jar over the burning candle (see figure 1). - Watch carefully what happens. - Feel the bottom of the jam jar. fig. 1 
Results	1 What happened to the flame? 2 What appeared on the inside of the jam jar? 3 What happened to the bottom of the jam jar?
Conclusion	If you seal off a candle from the air, are produced when a candle burns.
Discussion	Does your conclusion fit your hypothesis? <i>yes / no</i> The hypothesis has been <i>confirmed / rejected</i>.

2 DETECTING CARBON DIOXIDE

► Basics 2 | ► Learning objective 1.O.15 | ► Learning how to do research 2

 15-25 minutes

WHAT ARE YOU GOING TO DO?

In this practical activity, you will learn how to use limewater to detect carbon dioxide.

WHAT DO YOU NEED?

- ☐ 4 test tubes in a test tube rack
- ☐ 4 labels
- ☐ water that has boiled and cooled down again
- ☐ sparkling mineral water
- ☐ clear limewater

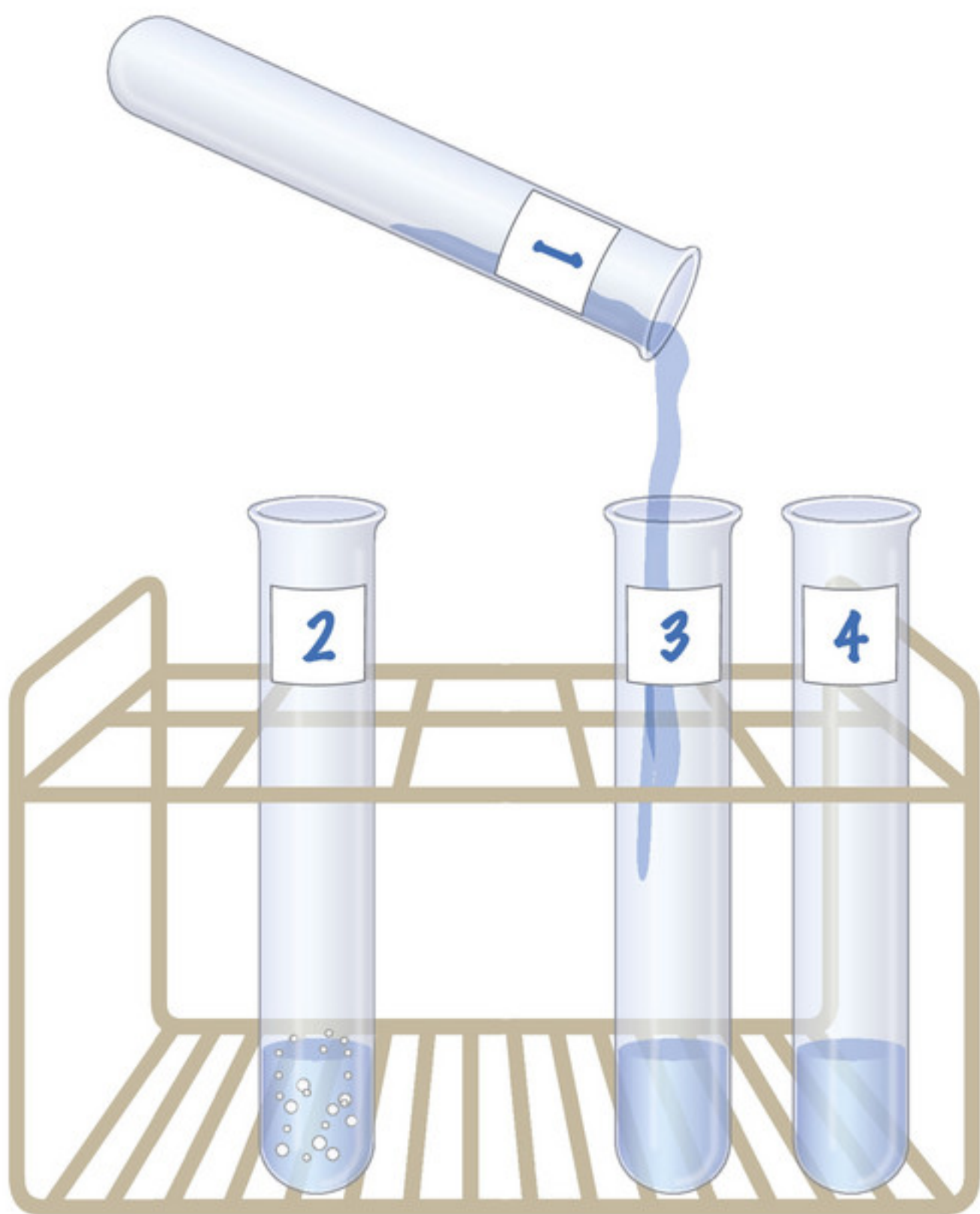
WORKING METHOD

- Stick a label on each test tube. Number the test tubes from 1 to 4.
- Pour water that has boiled (and cooled) into test tube 1 to a height of about 2 cm.
- Pour sparkling mineral water into test tube 2 to a height of about 2 cm.
- Pour clear limewater into test tubes 3 and 4 to a height of about 2 cm.
- Pour the contents of test tube 1 into test tube 3 (see figure 2).
- Pour the contents of test tube 2 into test tube 4.
- Complete the diagram.

	The limewater is
Boiled water + limewater	<i>not cloudy / cloudy</i>
Mineral water + limewater	<i>not cloudy / cloudy</i>

- What conclusion can you draw?

fig. 2



EXERCISE

- 1
- a What is the indicator for carbon dioxide?
 - b In this practical activity, you have demonstrated the presence of carbon dioxide. What was the control group?

3 CARBON DIOXIDE FROM A BURNING CANDLE

► Basics 2 | ► Learning objectives 1.2.4, 1.O.13, 1.O.14 and 1.O.15 | ► Learning how to do research 1 and 2

 45-50 minutes

WHAT ARE YOU GOING TO DO?

In this practical activity, you are going to investigate whether a burning candle produces carbon dioxide. You will do this by putting a burning candle under a jam jar together with a layer of clear limewater (see figure 3). You also need a control to show that the carbon dioxide could only have been produced by the burning candle.

WHAT DO YOU NEED?

The things you need are given in the table.

WORKING METHOD

- Think up a hypothesis and write it down in the table.
- Think about how you want to carry out the experiment and write that down in the table too. Ask your teacher to check it.
- Do the experiment and complete the rest of the table.



STUDY	CARBON DIOXIDE FROM A BURNING CANDLE
Study question	Is carbon dioxide produced when burning a candle?
Hypothesis	
What do you need?	☐ 2 jam jars with lids ☐ 2 candle ends ☐ clear limewater ☐ matches
Working method	
Results	
Conclusion	

Discussion	Does your conclusion fit your hypothesis? <i>yes / no</i> The hypothesis has been <i>confirmed / rejected</i>. Did everything go according to the working plan? If not, what went differently? Did you make accurate measurements? Explain your answer. Was the work plan in order? If not, what could have been done better? How reliable are your results?
------------	---

EXERCISE

1

- a What substances are produced when candle wax burns?
- b What is the indicator for carbon dioxide?
- c In this practical activity, you have demonstrated the presence of carbon dioxide. What was the control group?

4

THE OXYGEN LEVELS IN INHALED AND EXHALED AIR

► Basics 4 | ► Learning objectives 1.4.6, 1.O.13, 1.O.14 and 1.O.16 | ► Learning how to do research 1 and 2

 40-50 minutes

WHAT ARE YOU GOING TO DO?

In this practical activity, you will investigate the difference in the oxygen levels of inhaled and exhaled air. You will use a burning candle to measure the amount of oxygen. Do this practical activity together with a classmate.

WHAT DO YOU NEED?

The things you need are given in the table.

WORKING METHOD

Do the experiment and complete the rest of the table.

STUDY	THE OXYGEN LEVELS IN INHALED AND EXHALED AIR	
Study question	What is the difference between inhaled and exhaled air in oxygen content?	
Hypothesis		
What do you need?	☐ a piece of steel wire ☐ a candle end ☐ a sheet of glass ☐ a tall glass beaker	☐ a straw ☐ matches ☐ a watch or stopwatch

Working method

- Bend the piece of steel wire to make a shape like a large fish hook. Fix the candle end on the end of the piece of steel wire (see figure 4).
- Place the sheet of glass over the glass beaker (see figure 5). Leave a small opening and stick the straw through it.

fig. 4

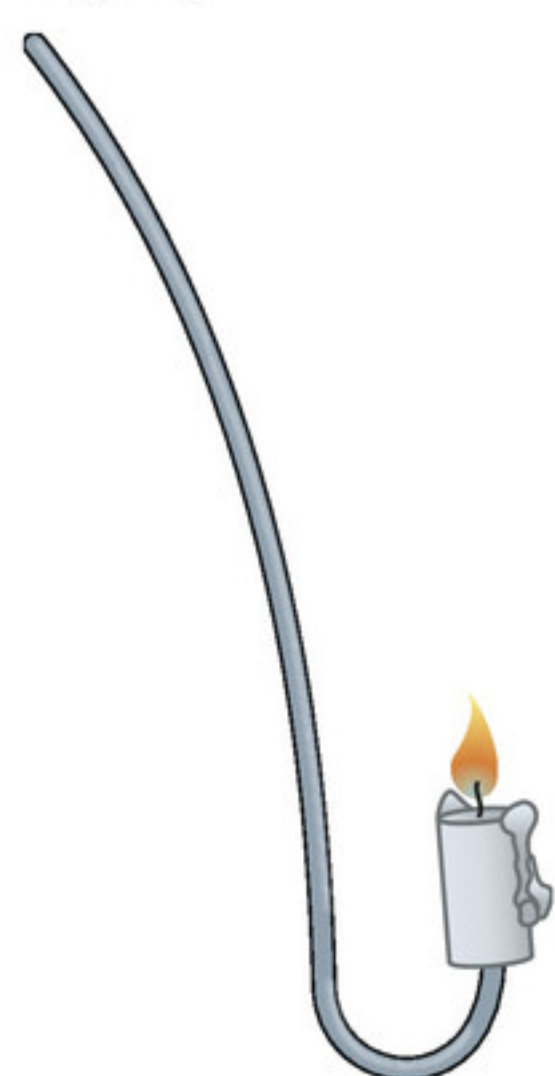
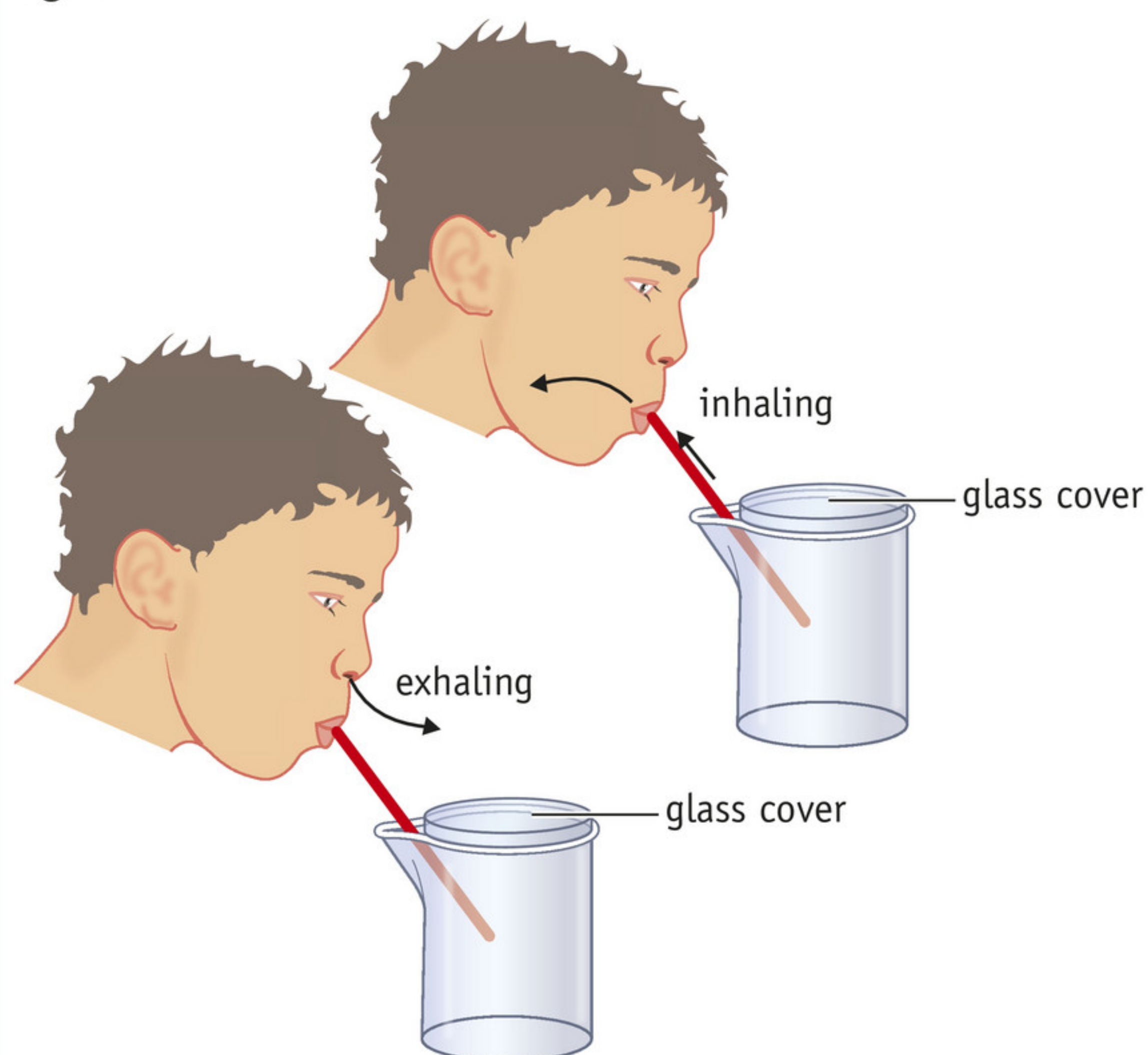


fig. 5



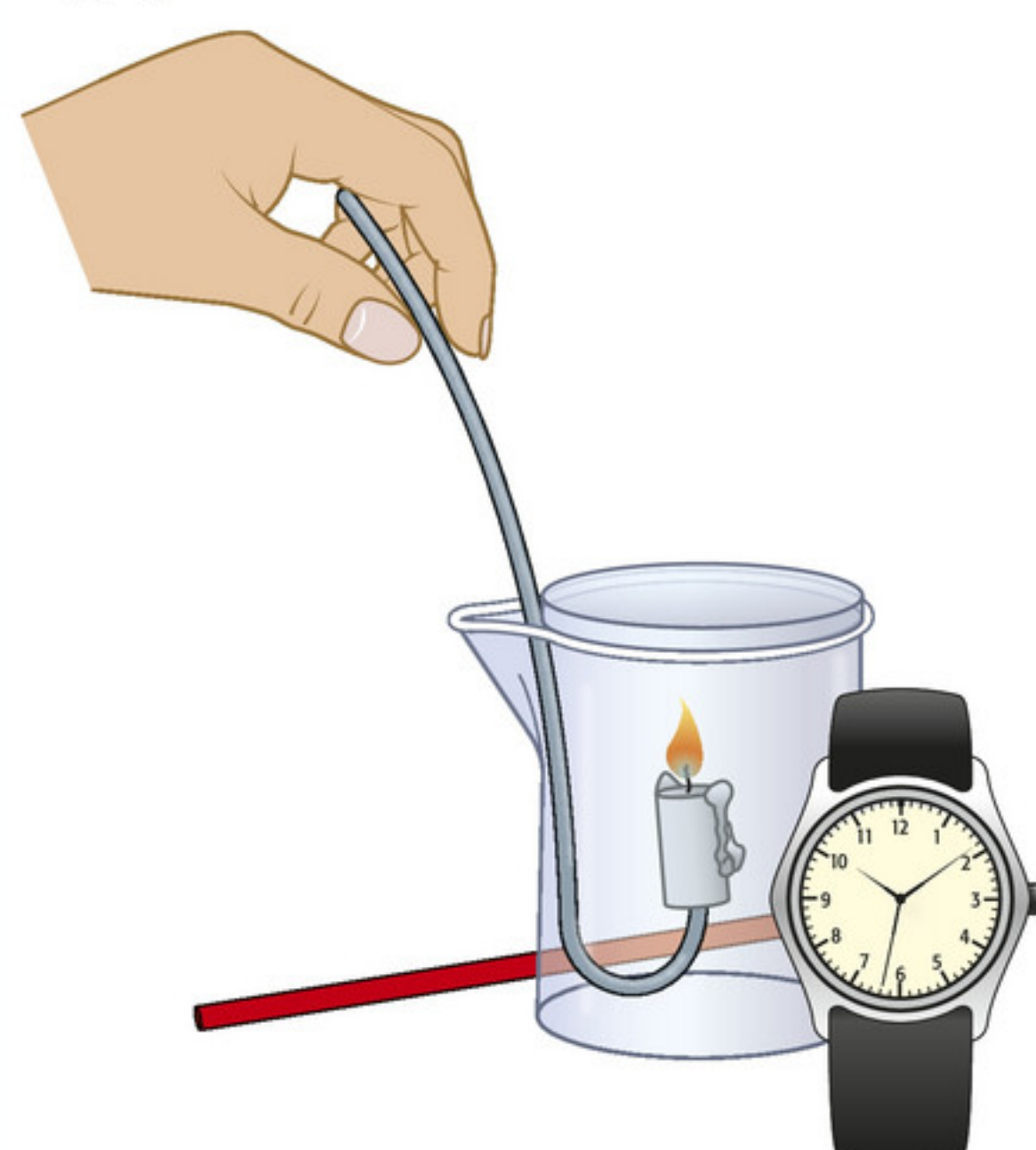
- Breathe in through the straw and out through your nose (see figure 6). Breathe very slowly.

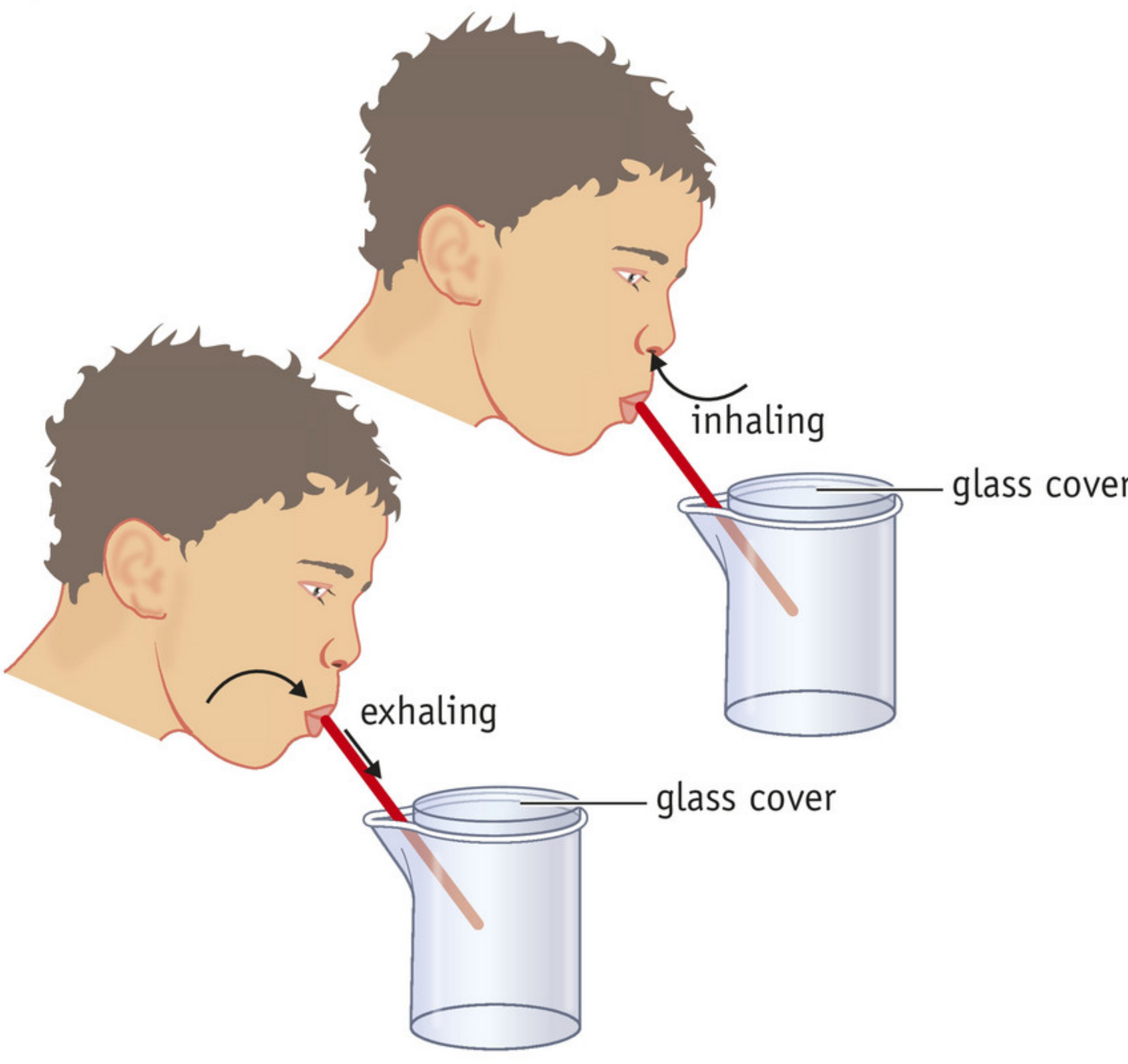
fig. 6



- When you have breathed in through the straw five times, let your classmate light the candle and use the watch or stopwatch.
- Lower the burning candle carefully into the glass beaker (see figure 7). Close the beaker off immediately with the glass sheet and start measuring the time. Stop the watch when the candle goes out.
- Write down how many seconds it took before the candle went out.

fig. 7



Working method	- Remove the glass sheet and the candle. Shake the beaker in the air to fill it with fresh air. - Repeat the experiment, but this time breathe in through your nose and breathe out through the straw (see figure 8). Breathe very slowly. Don't blow into the straw! fig. 8  - Lower the burning candle carefully into the glass beaker again. Then close the beaker immediately with the glass sheet. Get your classmate to measure the time again. - Write down how many seconds it took before the candle went out this time. - Shake the beaker in the air again. - Repeat the experiment but switch roles this time. Let your classmate breathe through the straw now.						
Results	<table><tr><th></th><th>Average time before the candle went out</th></tr><tr><td>Inhaled air</td><td>s</td></tr><tr><td>Exhaled air</td><td>s</td></tr></table>		Average time before the candle went out	Inhaled air	s	Exhaled air	s
	Average time before the candle went out						
Inhaled air	s						
Exhaled air	s						
Conclusion							
Discussion	Does your conclusion fit your hypothesis? <i>yes / no</i> The hypothesis has been <i>confirmed / rejected</i>. Did everything go according to the working plan? If not, what went differently? Did you make accurate measurements? Explain your answer. Was the work plan in order? If not, what could have been done better? How reliable are your results?						

5

THE CARBON DIOXIDE LEVELS IN INHALED AND EXHALED AIR

► Basics 4 | ► Learning objectives 1.4.6, 1.0.13, 1.0.14 and 1.0.16 | ► Learning how to do research 1 and 2

 40-50 minutes

WHAT ARE YOU GOING TO DO?

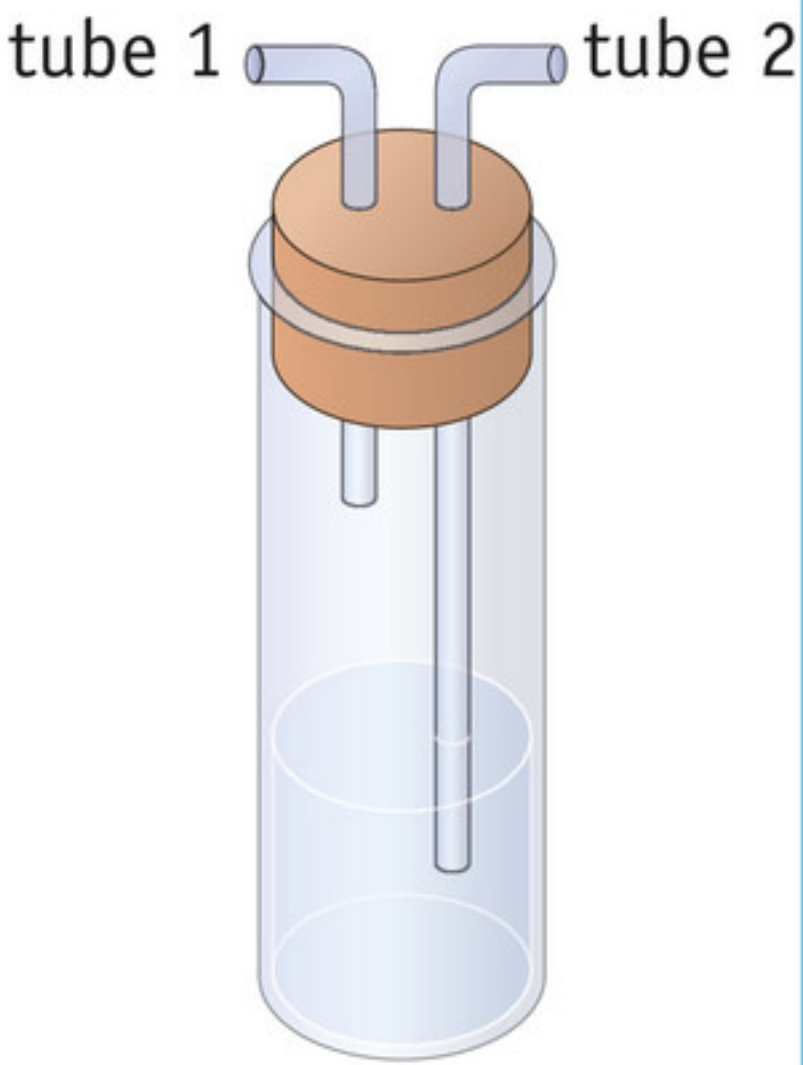
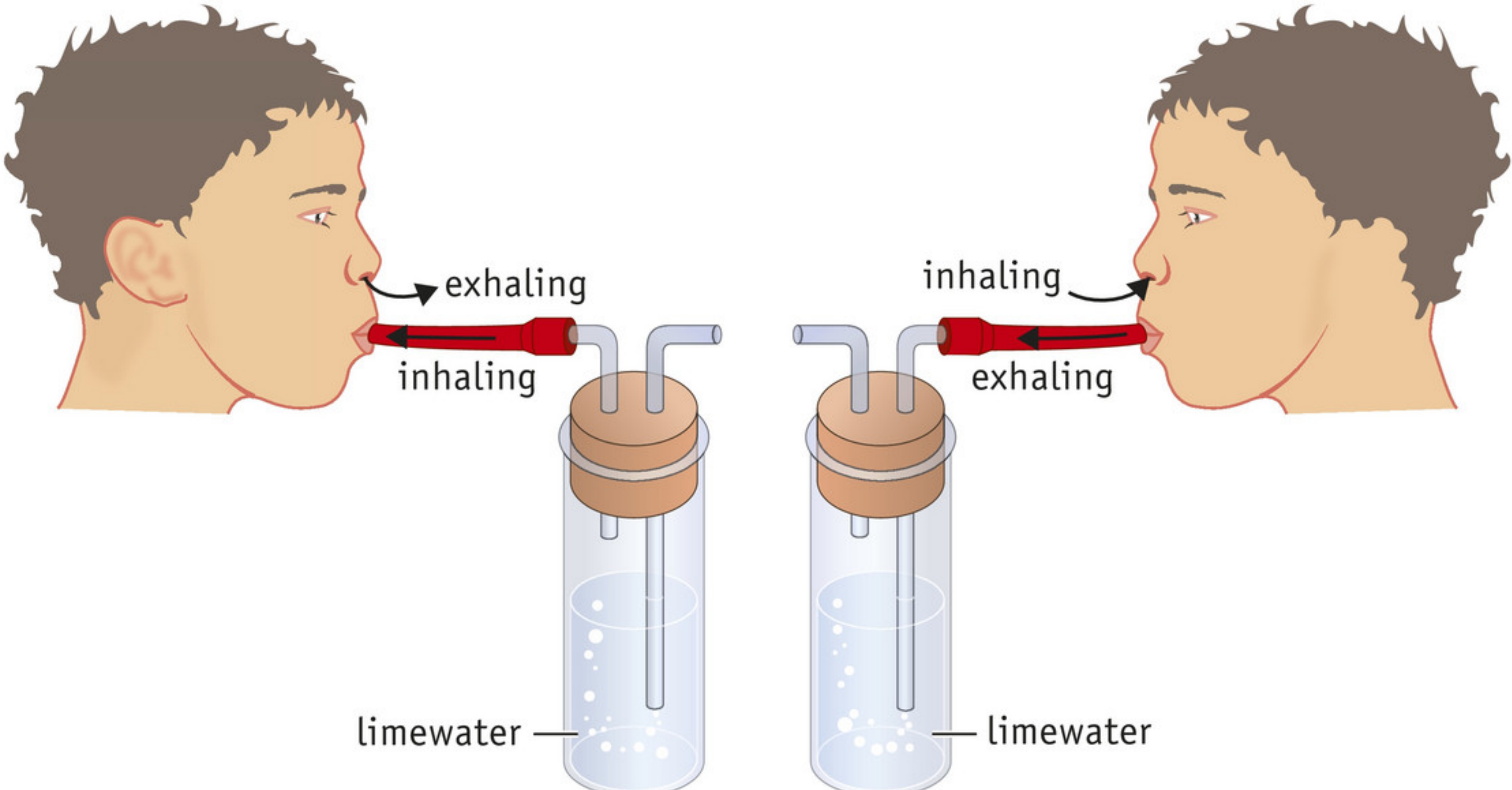
In this practical activity, you will investigate the difference in the carbon dioxide levels of inhaled and exhaled air. You will use limewater to detect the carbon dioxide.

WHAT DO YOU NEED?

The things you need are given in the table.

WORKING METHOD

Do the experiment and complete the rest of the table.

STUDY	THE CARBON DIOXIDE LEVELS IN INHALED AND EXHALED AIR	
Study question	What is the difference between inhaled and exhaled air in carbon dioxide content?	
Hypothesis		
What do you need?	☐ a large test tube with stopper and with one long and one short tube stuck through the stopper (see figure 9) ☐ a rubber hose ☐ clear limewater	fig. 9 
Working method	• Fill the test tube up to about one third full with limewater and place the stopper with the tubes in the test tube. • Attach the rubber hose to the end of tube 1. Breathe in through tube 1 and out through your nose (see figure 10). Breathe like this for one minute. The air you are inhaling will pass through the limewater. • Remove the used limewater from the test tube and pour in fresh limewater. • Attach the rubber hose to the end of tube 2. Breathe in through your nose and breathe out through tube 2. Breathe like this for one minute. Now the air you are exhaling will pass through the limewater. fig. 10 	

Results	Present your results in a table.
Conclusion	
Discussion	Does your conclusion fit your hypothesis? <i>yes / no</i> The hypothesis has been <i>confirmed / rejected</i>. Did everything go according to the working plan? If not, what went differently? Did you make accurate measurements? Explain your answer. Was the work plan in order? If not, what could have been done better? How reliable are your results?

EXERCISE

1

- a** Write down the composition of exhaled air in the table. Use: 1 – 5 – 16 – 78.

	Inhaled air	Exhaled air
Nitrogen	78%	%
Oxygen	21%	%
Noble gases	1%	%
Carbon dioxide	0.04%	%

- b** According to the table, exhaled air still contains oxygen.
Is that consistent with the result of Practical 4? Explain your answer.
- c** Are the results of your experiment in line with the data in the table of Question (a)?
yes / no

6

A MODEL OF ABDOMINAL BREATHING

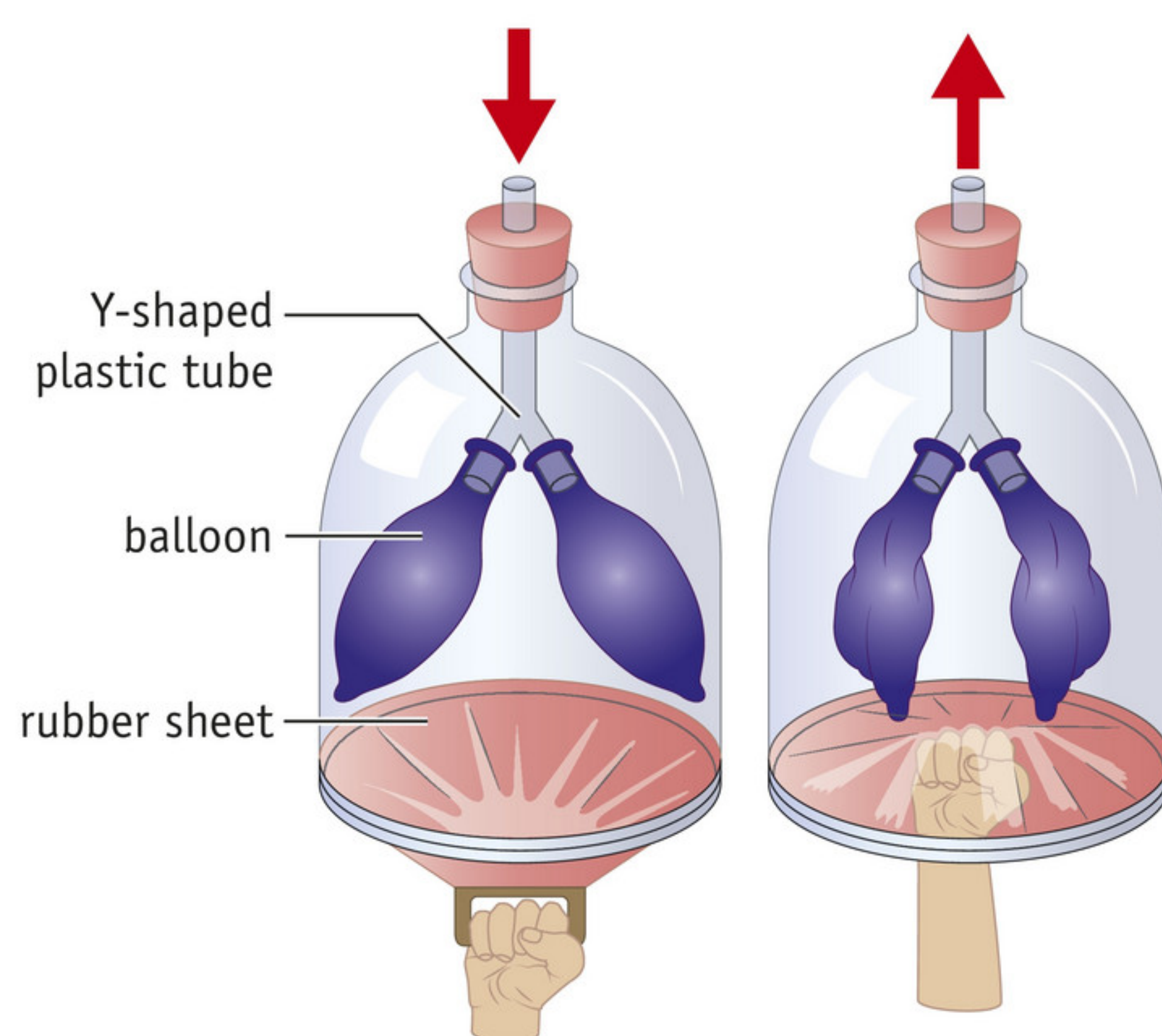
► Basics 4 | ► Learning objective 1.4.7

🕒 10-15 minutes

WHAT ARE YOU GOING TO DO?

In this demonstration practical activity, you will be shown a model of the ribcage (see figure 11). Your teacher will move the rubber layer at the bottom of the model up and down.

fig. 11



EXERCISES

1

- a What do the balloons represent?
- b What does the Y-shaped plastic tube represent?
- c What does the rubber sheet at the bottom of the model represent?

2

- a What happens to the balloons when the rubber sheet is pulled downwards?
- b What does that movement represent?
inhalation / exhalation
- c What happens to the balloons when the rubber sheet is pushed upwards?

7 HOW ORGANS FUNCTION DURING PHYSICAL EXERCISE

► Basics 4 | ► Learning objectives 1.2.3, 1.4.7, 1.O.13 and 1.O.14 | ► Learning how to do research 1

 Lesson 1: 15-20 minutes, lesson 2: 30-40 minutes

WHAT ARE YOU GOING TO DO?

In this practical activity, you will be thinking up an experiment to show which organs work harder during physical exercise.

WHAT DO YOU NEED?

Think of everything you need yourself.

WORKING METHOD

- Fill the hypothesis, the things you need and the working method into the table. Ask your teacher to check it. They may give you tips on how to improve your work plan.
- Do the experiment during the second lesson period and complete the rest of the table.

STUDY	HOW ORGANS FUNCTION DURING PHYSICAL EXERCISE
Study question	Which organs work harder during physical exertion?
Hypothesis	
What do you need?	
Working method	
Results	
Conclusion	

Discussion	Does your conclusion fit your hypothesis? <i>yes / no</i> The hypothesis has been <i>confirmed / rejected</i>. Did everything go according to the working plan? If not, what went differently? Did you make accurate measurements? Explain your answer. Was the work plan in order? If not, what could have been done better? How reliable are your results?
------------	---

8

VITAL CAPACITY

► Basics 5 | ► Learning objectives 1.O.13, 1.O.14 and 1.O.17 | ► Learning how to do research 1 and 3

 Lesson 1: 50 minutes, lesson 2: 30-40 minutes

WHAT ARE YOU GOING TO DO?

Different people do not all have the same vital capacity. The vital capacity depends on various factors. In this practical activity, you will investigate the relationship between vital capacity and height.
The research group is all the pupils in your class.

WHAT DO YOU NEED?

Think of everything you need yourself.

WORKING METHOD

- Fill the hypothesis, the things you need and the working method into the table. Ask your teacher to check it. They may give you tips on how to improve your work plan.
- Do the experiment and complete the rest of the table. There is time for this in both the first and second lesson periods.
- When you write down the discussion part, include an evaluation of the conclusion and how reliable the results are.

STUDY	VITAL CAPACITY AND HEIGHT
Study question	Is there a relationship between a person's vital capacity and their height?
Hypothesis	
What do you need?	
Working method	
Results	
Conclusion	
Discussion	

9

TRACHEAE AND SPIRACLES

► Basics 6 | ► Learning objective 1.6.10

 20-25 minutes

WHAT ARE YOU GOING TO DO?

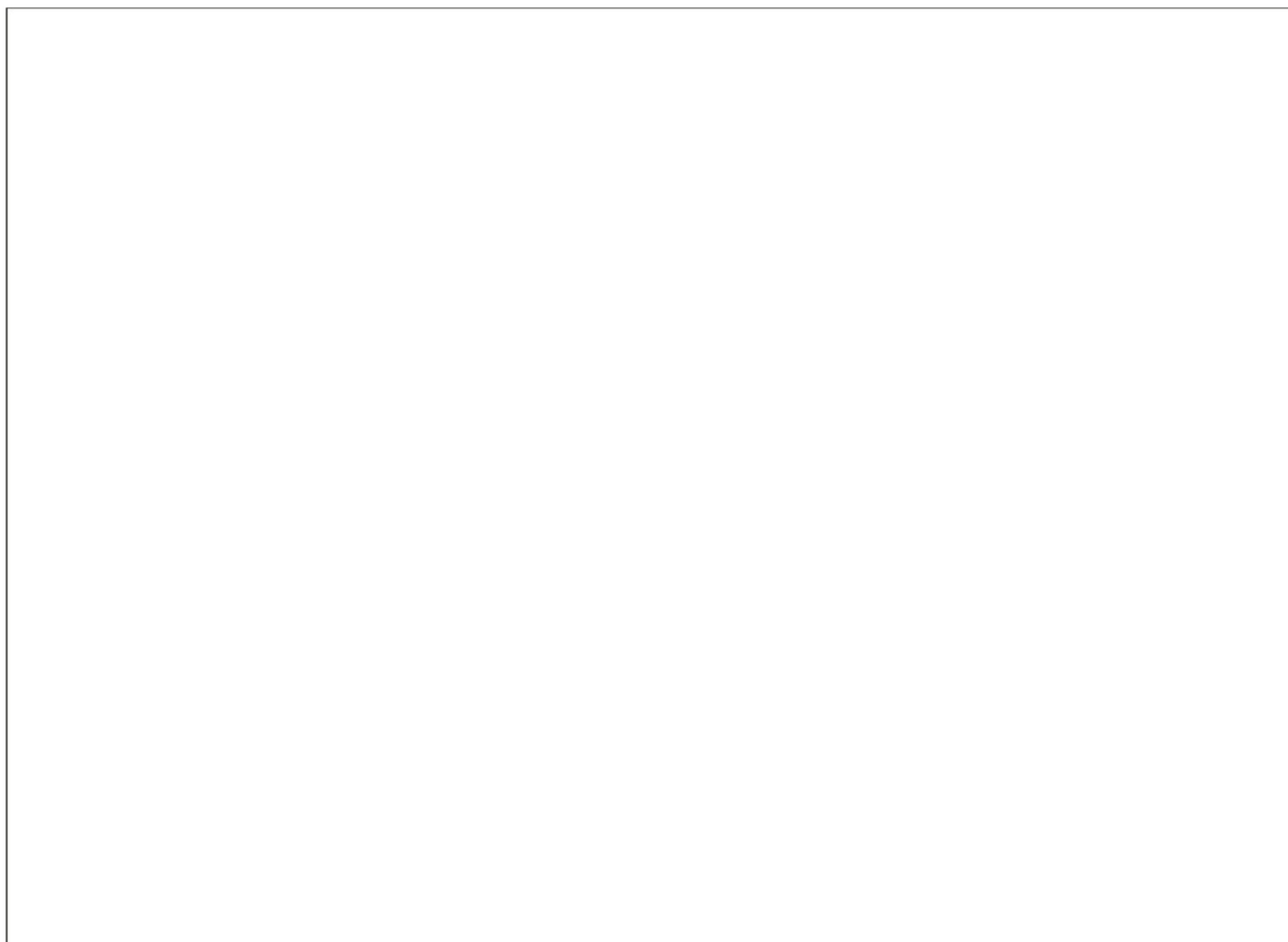
In this practical activity, you will be looking at slides of tracheae and spiracles.

WHAT DO YOU NEED?

- ☐ a ready-made specimen of the tracheae of an insect
- ☐ a ready-made specimen of the spiracles of an insect
- ☐ a microscope
- ☐ drawing materials

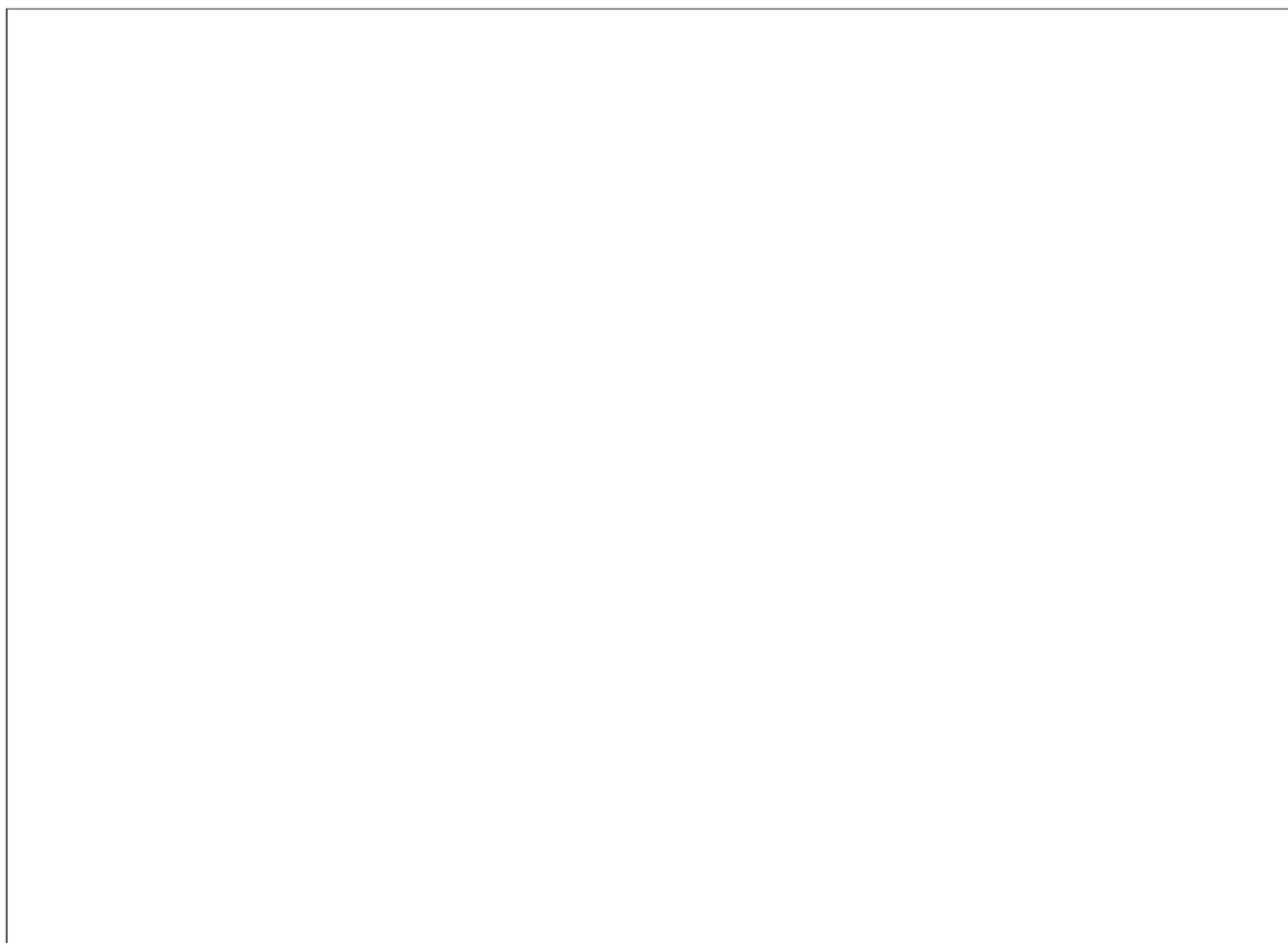
WORKING METHOD

- Examine the specimen of the tracheae under the microscope at a magnification of 100×.
- Make a drawing of a trachea and its branches. Add a title and note the magnification below your drawing.



.....

- Examine the specimen of the spiracles under the microscope at a magnification of 100×.
- Make a drawing of a spiracle. Add a title and note the magnification below your drawing.



10

THE GILLS OF A FISH

► Basics 6 | ► Learning objective 1.6.10

 35-50 minutes

WHAT ARE YOU GOING TO DO?

In this practical activity, you are going to examine and draw the gills of a fish. You will be working with a fish head for this. You should treat animals with respect, even when they are dead or when you are working with parts of an animal. So you should only carry out the tasks that are described here or that your teacher tells you to do.

WHAT DO YOU NEED?

- ☐ a fish head
- ☐ a saucer
- ☐ tweezers
- ☐ scissors
- ☐ a Petri dish
- ☐ a magnifying glass
- ☐ drawing materials

WORKING METHOD

- Put the fish head on the saucer in a way that lets you get a good view of the side.

- Make a true-to-life drawing of a side view of the head. Label the following parts:
mouth – gill flap – lip – nostril – eye – fin.



- Carefully lift up a gill flap (see figure 12). You will see the gills. Carefully cut away the gill flap with the help of the tweezers.

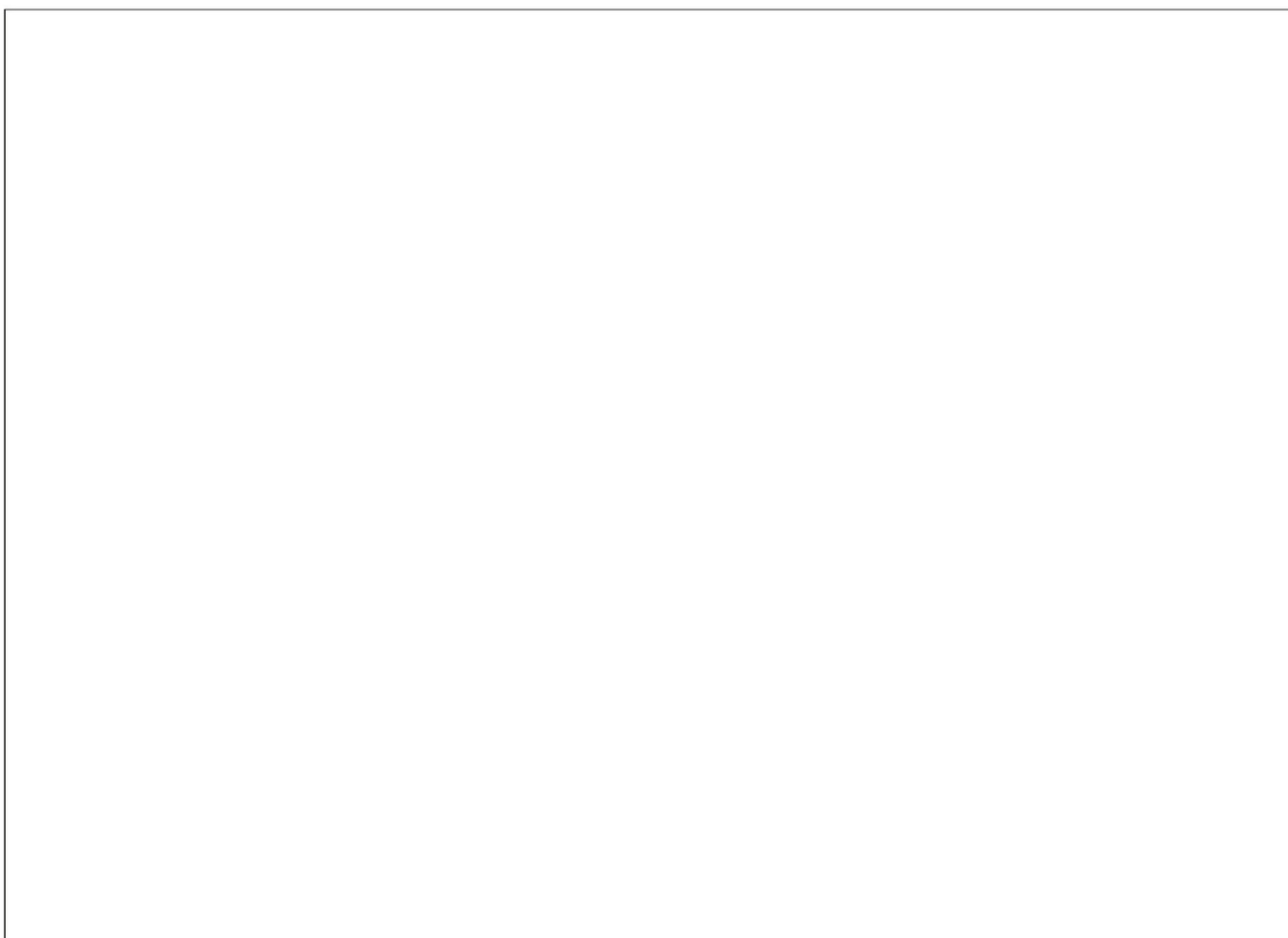
fig. 12



- Make a schematic drawing of the position of the gills in the gill cavity. Label the *gills*.



- Turn the fish head upside down and carefully cut open the floor of the mouth. You will see the gills on the left and right, attached to the gill arches. Carefully cut out one gill and put it in the Petri dish. Add water to stop it from drying out.
- Examine the gill under the magnifying glass. You will now see the gill arch and the gill lamellae.
- Make a schematic drawing of the removed gill. Label the following parts:
gill arch – gill lamella.



- Clear away the fish remains and clean your materials with soap and water.

Summary

BASICS 1

METABOLISM

1 You can explain that plants use photosynthesis to store energy in the form of glucose.

- Chloroplasts convert carbon dioxide and water into glucose.
 - That needs energy. The energy comes from sunlight.
 - Photosynthesis:

water + carbon dioxide + energy → glucose + oxygen

- Glucose is an energy-rich compound.

2 You can explain that breaking down glucose releases energy.

- Cells use glucose as an energy source.
 - When glucose is broken down, the energy stored in it is released.
 - The energy that is released is used for the cell's metabolism.
 - Glucose is broken down in mitochondria.

BASICS 2

RESPIRATION AND COMBUSTION

3 You can explain the relationship between respiration in cells and physical activity.

- The breakdown of glucose in cells is a form of combustion, a metabolic process called respiration.
 - Glucose is the most widely used fuel in cells.
 - Respiration releases energy, for example as movement and heat.
- Respiration takes place in all the cells of an organism.
 - Respiration goes on all the time, day and night.
- The amount of energy you need depends on the physical effort you are making.
 - The greater the physical effort, the more combustion takes place.
 - More fuel is then needed. More waste products are also produced.
 - Organs such as the lungs and heart will then be working harder.

4 You know that respiration uses oxygen and creates carbon dioxide.

- Oxygen is needed if fuel is to be burned.
- Combustion in a cell:

glucose + oxygen → water + carbon dioxide + energy

BASICS 3

THE RESPIRATORY SYSTEM

5 You can name parts of the respiratory system with their features and functions.

- The respiratory system consists largely of tubes lined with a mucous membrane.
 - Germs and dust particles remain stuck to the mucus.
 - Cilia move the mucus towards the back of the pharynx where it is then swallowed.
- Nasal cavity:
 - Nasal hairs stop large dust particles from getting in.
 - The nasal lining warms and moistens the air as it flows in.
 - The olfactory system checks the incoming air.
- Pharynx (throat): this is where the uvula and the epiglottis are.
 - During breathing, the uvula and the epiglottis are open.
 - During swallowing, the uvula closes off the nasal cavity and the epiglottis closes off the windpipe.
 - Choking: the epiglottis does not close the airway off during swallowing.
- Windpipe and bronchi:

- The wall is reinforced by horseshoe-shaped rings of cartilage that keep the windpipe open.
- The windpipe branches into bronchi, which are also reinforced by cartilage rings.
- Bronchioles: branches of the bronchi.
 - The walls of the smaller bronchioles have muscles.
- At the end of the bronchioles are the alveoli.
 - Alveoli are surrounded by a network of small blood vessels known as the pulmonary capillaries.

BASICS 4

BREATHING

6 You can state the differences between inhaled air and exhaled air.

- Gas exchange takes place in the alveoli.
 - Oxygen from the air is absorbed into the blood in the pulmonary capillaries.
 - Carbon dioxide from the blood passes from the pulmonary capillaries into the air in the alveoli.
 - The blood becomes rich in oxygen and low in carbon dioxide.
- Gas exchange can take place quickly in the lungs.
 - Taken all together, the alveoli have a large surface area.
 - The alveolar walls are very thin.
- The air that you exhale contains:
 - less oxygen
 - more carbon dioxide
 - and more water vapour than the air that you breathe in

7 You can describe how inhalation and exhalation are achieved.

- Normal breathing uses both chest breathing and abdominal breathing.
 - In chest breathing (thoracic breathing), the ribs and breastbone move up and down.

Inhaling	Exhaling
1 The ribs and the breastbone move upwards.	1 The ribs and the breastbone move downwards.
2 The thoracic cavity becomes bigger.	2 The thoracic cavity becomes smaller.
3 The lungs become bigger.	3 The lungs become smaller.
4 Air flows in.	4 Air flows out.

- In abdominal breathing (diaphragmatic breathing), the diaphragm moves up and down. This makes the abdominal wall move back and forth.

Inhaling	Exhaling
1 The diaphragm moves down (the abdominal wall moves forward).	1 The diaphragm moves up (the abdominal wall goes back).
2 The thoracic cavity becomes bigger.	2 The thoracic cavity becomes smaller.
3 The lungs become bigger.	3 The lungs become smaller.
4 Air flows in.	4 Air flows out.

BASICS 5

HEALTHY AIRWAYS

8 You can explain what you can do for yourself to keep your airways healthy.

- Not smoking:
 - Tobacco smoke contains substances that can be harmful to the lungs.
- Sports or exercise:
 - This improves your fitness and gives you stronger lungs.
- Singing or playing a wind instrument:
 - Breathing exercises make your lungs stronger.
- Smog is a type of air pollution that consists largely of fine particulates.
 - It is better not to play sports outdoors if there is a lot of smog.
- If there is not enough fresh air, you may start to lose concentration, get headaches or feel fatigued.
 - Bacteria and viruses are also able to spread more easily.
 - Make sure there is enough ventilation.

9 You can describe what hay fever is.

- Allergy: hypersensitivity to one or more substances.
- Hay fever: an allergy to pollen grains.
 - Allergic reactions in hay fever: tears in the eyes, inflamed mucous membranes, a runny nose and sneezing fits
 - Allergic reaction to tree pollen: suffer from hay fever mostly in the spring
 - Allergic reaction to grass pollen: suffer from hay fever mostly in the summer

BASICS 6

BREATHING IN ANIMALS

10 You can describe how gas exchange occurs in various different groups of animals.

- Unicellular organisms: gas exchange through the cell membrane.
- Insects have tracheae: branched tubes of air that terminate everywhere throughout the body.
 - Spiracles are openings that let air flow into the tracheae.
- Fish have gills. They are just behind the head, in the gill cavity.
 - The gill cavities are covered by gill flaps or opercula.
 - A gill consists of a gill arch on which there are a large number of gill lamellae.
- Birds have lungs with air sacs.
 - Birds' lungs do not get larger and smaller, but the air sacs do.
 - The air sacs let gas exchange occur more quickly in birds than in mammals.

EXTRA 7

SMOKING TOBACCO AND CANNABIS**11 You know the potential consequences of addiction to tobacco and cannabis.**

- Cigarette smoke is a mixture of gases and tiny droplets of tar.
 - Components of tobacco smoke include nicotine, tar and carbon monoxide.
- Nicotine is what gets you addicted to smoking.
 - Habituation, psychological dependency and physical dependency all occur.
 - A smoker's body needs nicotine.
 - When a smoker stops smoking, withdrawal symptoms can occur.
- Tar damages the lungs.
 - The cilia get damaged by the tar.
 - There are substances in the tar that cause lung cancer.
- Carbon monoxide reduces the blood's ability to transport oxygen.
- The psychoactive substance in cannabis is THC.
 - Cannabis also contains CBD (cannabidiol). CBD is not psychoactive.
- Short-term effects of THC include elevated pulse rate, reduced blood pressure, headaches, dizziness, drowsiness, anxiety, and concentration and memory problems
- Long-term effects of THC include addiction, insomnia, depression, concentration problems, damage to airways, lung cancer and psychological disorders (depression, anxiety or schizophrenia)

EXTRA 8

COLD-BLOODED AND WARM-BLOODED**12 You can describe the difference in cellular respiration between cold-blooded and warm-blooded animals.**

- In cold-blooded animals, the body temperature depends on the temperature of the surroundings.
 - At low temperatures, respiration in the cells is slower. Not much energy is then released.
 - This means that cold-blooded animals are not very active in cold temperatures.
- Hibernation: reduced body temperature and slowed metabolism.
- In warm-blooded animals, the body temperature is constant.
 - The activity of warm-blooded animals depends less on the temperature of their surroundings.
- To keep the body temperature constant, a lot of energy (and therefore a lot of respiration) is needed and loss of heat has to be avoided.
 - Warm-blooded animals often have some form of insulation.
 - Many warm-blooded animals migrate to warmer areas in the autumn. There are also warm-blooded animals that hibernate.

RESEARCH

LEARNING HOW TO DO RESEARCH & PRACTICAL ACTIVITIES**13 You can evaluate the hypothesis by comparing it against the conclusion.****14 You can evaluate whether the results are reliable.****15 You can test for carbon dioxide with an indicator.****16 You can show differences in the levels of carbon dioxide and oxygen.****17 You can describe what the tidal volume, the vital capacity and the lung volume are.**

 Go to the *Flash cards* and the *Diagnostic test*.

2

Nutrition and digestion

Your food contains all kinds of substances that your body needs. Before your body can use these substances, the food needs to be digested. There are healthy foods and less healthy ones.

BASICS

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1 Food and nutrients

LEARNING OBJECTIVES

- 2.1.1

You can state the functions of nutrients and dietary fibre in foods.
- 2.1.2

You can name six groups of nutrients and list their functions.
- Learning how to do research 1

► Practical activities 1, 2 and 3

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES	
	2.1.1	2.1.2
Remembering	1a	
Understanding	1b, 4	2, 3, 4
Using	5abc, 6, 11ab	5abc, 6, 8, 11ab
Analysing	5d, 7, 10, 11c	5d, 9, 10, 11c

Food comes from the roots, stems, leaves, fruits and seeds of plants. Many people also eat animals and animal products. Food contains all kinds of nutrients that your body needs.

ANIMAL OR VEGETABLE?

All the products that you eat or drink are **foodstuffs**. Foodstuffs can be vegetable or animal in origin (see figure 1).
Vegetable foodstuffs are foods that come from plants or are made from plants.
Animal foodstuffs come from animals or animal products. Meat generally comes from animals that were bred for the purpose. Eggs and milk are also animal products. Milk is used for making dairy products such as butter, cheese and yoghurt.

fig. 1 Foodstuffs.



1 Plant-based foodstuffs



2 Animal-based foodstuffs

There are also vegetable products that you can use instead of butter and milk, such as low-fat margarine and soya milk (see figure 2). Soya milk is made from soy beans (a kind of pulse). Low-fat margarine is made from vegetable oils, for instance from sunflower seeds or olives.

fig. 2 Low-fat margarine and soya milk.



THE FUNCTIONS OF NUTRIENTS

Foods contain nutrients. **Nutrients** are substances that your body needs for energy, growth and recovery (see figure 3). Nutrients can have four different functions in your body:

- fuel
- building material
- reserves
- protection

Fuels provide energy. Respiration takes place in every single cell of your body. This is a form of combustion that needs fuel to supply energy. All the organs in your body need energy to function (see figure 3.1). Energy is needed to keep your body temperature up and for growth, development and repairs to your body.

The **building materials** are the building blocks needed for your body to grow, develop and repair wounds and other damage (see figure 3.2). Your body can use the nutrient building blocks to help create new cells and tissues.

Reserves are stocks that are not needed immediately as building materials or fuel. They can be stored up in your body.

Protective substances make sure that you do not get sick.

fig. 3 Your body needs nutrients.



1 fuels to get energy



2 building materials for making new cells

SIX GROUPS OF NUTRIENTS

There are six groups of nutrients: proteins, carbohydrates, fats, water, minerals and vitamins. You need all these groups of nutrients if you want to stay healthy. Deficiencies in minerals and vitamins in particular can cause illness. Minerals and vitamins are protective substances.

PROTEINS

Proteins are important building blocks for your body. A lot of proteins are needed when cytoplasm is formed, for instance. You also need protein for building up muscle. Any excess of protein in your diet is used as fuel, or converted into fats and stored as reserves. Figure 4 shows you foods that contain a lot of protein.

CARBOHYDRATES

Carbohydrates include sugars (such as glucose), starch and glycogen. Dietary fibre is made of carbohydrates too. Carbohydrates are used primarily as fuel, but your body can also use them as building materials. If you eat more carbohydrates than you need, they are converted into fats and stored as reserves. Glucose can be converted into glycogen and stored in the liver and in your muscles.

Figure 5 shows you foods that contain a lot of carbohydrates. There is a lot of starch in potatoes, seeds and grain products; jam and fruit juice (for example) contain a lot of sugar. Animal-based foodstuffs generally do not contain much in the way of carbohydrates.

fig. 4 Foods that contain a lot of protein.



fig. 5 Foods that contain a lot of carbohydrates.



FATS

Fats are used primarily as fuel, but can also act as building materials or as reserves. There is no need for your food to contain much fat. If you take in more fat than you need, it is stored as a food reserve, for example beneath your skin. The subcutaneous layer of fat then gets thicker. Figure 6 shows you foodstuffs that contain a lot of fats.

WATER

Your body is approximately 60% **water**. Water is therefore an important building material for your body. Many other organisms consist mostly of water too. Water is needed for transporting substances inside your body. Most substances in your body can only be transported properly if they are dissolved in water, for instance in the blood (which consists largely of water). Drinks, fruit and some vegetables contain a lot of water (see figure 7).

fig. 6 Foods that contain a lot of fats.



fig. 7 Foods that contain a lot of water.



MINERALS

Minerals are often also referred to as ‘salts’. Examples of minerals are calcium (calcium carbonate), sodium, magnesium and iron. You need a variety of minerals as building blocks. Calcium carbonate is needed for bone growth, for instance. Minerals are also protective substances that you need if you are to stay healthy.

VITAMINS

Vitamins are used as building materials and for protection. If you do not get enough vitamins, you will become ill. But eating too much of the vitamins can also make you ill. If you have a normal and healthy diet, you will get enough vitamins. There is then no need to use vitamin pills.

Vitamins are identified by letters. Important vitamins are A, B, C, D and K. Vitamin A is needed for producing skin and for seeing well; vitamin D is needed for fixing calcium phosphate in your bones.

Figures 8 and 9 shows you foodstuffs that contain a lot of vitamins and minerals.

fig. 8 Foods that contain a lot of minerals and the vitamins A, B, D, E and K.



fig. 9 Foods that contain a lot of minerals and the vitamins B, C and K.



DIETARY FIBRE

Dietary fibre (or just ‘fibre’) is a collective name for vegetable materials that your body cannot digest. Fibre is one of the carbohydrates and it comes from the cell walls of plants. It can be found in particular in vegetables, fruit, potatoes, wholemeal bread, wholemeal breakfast cereals, pulses and nuts; it helps make you feel replete (the feeling that you are ‘full’ and have eaten enough). Dietary fibre is needed for proper intestinal functioning.

KNOWLEDGE

1

- a**
- All the products that you eat or drink are known as *nutrients* / *foodstuffs*.
 - Low-fat margarine is *an animal* / *a vegetable* product.
 - Butter is *an animal* / *a vegetable* product.
- Foods* / *nutrients* are the usable components of *foods* / *nutrients*.
- b** Which term belongs with the description?
- | | | |
|---|-----------------------|---|
| A deficiencies of these can cause illness | ☐ | ☐ 1 protective substances |
| B provide energy | ☐ | ☐ 2 building materials |
| C needed so that cells can build up tissues | ☐ | ☐ 3 fuels |
| D the indigestible parts of plant-derived foods | ☐ | ☐ 4 food reserves |
| E are stored for later use | ☐ | ☐ 5 dietary fibre |

2

Which group of nutrients belongs with each description? Choose from: *proteins* – *carbohydrates* – *minerals* – *fats* – *vitamins* – *water*.

- Primarily as fuel, but also as building blocks and a reserve of food stored under the skin:
- A building material that is also used for transporting substances:
- Building materials and protective substances, for instance to help you see well:
- Primarily as building material, but can also be used as fuel:
- Building material and protective substances, for example the calcium phosphate used for building up bones:
- Primarily as fuel, but also as building material and food reserves (for example sugars and starch):

3

- a**
- Fish contains a lot of *protein* / *carbohydrates* / *minerals* / *vitamins* / *water*.
 - Cucumber contains a lot of *protein* / *carbohydrates* / *minerals* / *fats* / *vitamins* / *water*.
- b** The foods shown in figure 10 contain a lot of *proteins* / *carbohydrates* / *minerals* / *fats* / *vitamins* / *dietary fibre* / *water*.
- c** Write down three foods that contain a lot of fat.
- d** Write down three foodstuffs that contain a lot of carbohydrates.

fig. 10



4



Summary

- What is the difference between nutrients and foodstuffs?
- Give examples of animal and vegetable foodstuffs.
- What is dietary fibre and what is its function?
- What are the six groups of nutrients and what are the functions of each group?

INSIGHT

5

Figures 11, 12 and 13 show you various foods.

- The foods shown in figure 11 contain mostly *protective substances / building blocks / fuels / food reserves*
- The foods shown in figure 12 contain mostly *protective substances / building blocks / fuels / food reserves*
- The foods shown in figure 13 contain mostly *protective substances and building blocks / fuels / food reserves*
- Explain why beans contain lots of building materials and fuels.

fig. 11



fig. 12



fig. 13



6

Figure 14 shows two menus.

- Explain which of the two menus contains more protective substances.
- Explain which of the two menus contains more fuels.
- Which menu would be better for preventing intestinal problems? Explain your answer.

fig. 14 Two menus.



menu 1

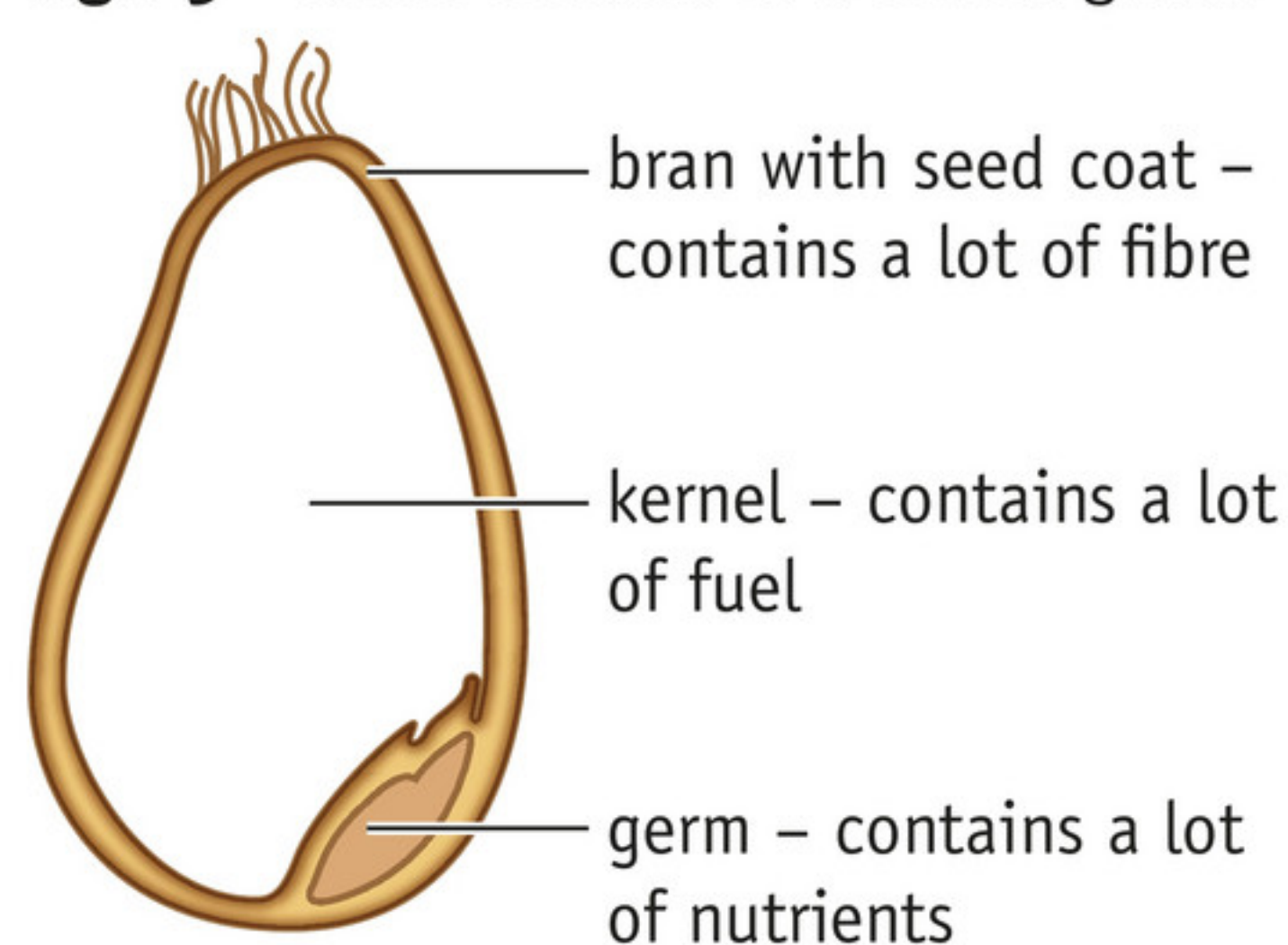


menu 2

7

Figure 15 shows that a cereal grain is made up of bran, a kernel and a germ. In white bread, two of these three components are removed; in wholemeal bread they are not removed. That is why wholemeal bread has more nutrients than white bread. Which parts are removed before white bread is prepared? Explain your answer.

fig. 15 Cross-section of a cereal grain.



8

Record everything you eat and drink for one whole day. Store the list along with this exercise in your book. Use sticky tape or a paperclip to attach it on one side.

Compare your list against that of a classmate (or the whole class).

- What food products did you both/all of you eat?
- What products did you both/all of you drink?
- What products did someone else note down that you never eat or drink?

9

There may be a lot of glucose in the blood during and after a meal. When the glucose level in your blood is high, the islets of Langerhans produce the hormone insulin. Under the influence of insulin, the liver and muscles convert glucose into glycogen and store it. When the glucose level drops, the islets of Langerhans produce glucagon. Under the influence of glucagon, glycogen is converted into glucose, which is then released into the blood.

Lucy eats two meals (see figures 16 and 17).

- a At what two times in the graph in figure 16 had Lucy just started eating?
at time t_1 / t_2 / t_3 / t_4 / t_5 / t_6
- b At which two times is Lucy's body producing glucagon?
at time t_1 / t_2 / t_3 / t_4 / t_5 / t_6
- c At which two times does Lucy's body produce insulin?
at time t_1 / t_2 / t_3 / t_4 / t_5 / t_6
- d At time t_2 , Lucy ate a salad with vegetables / white bread with jam.

fig. 16 Lucy's glucose level.

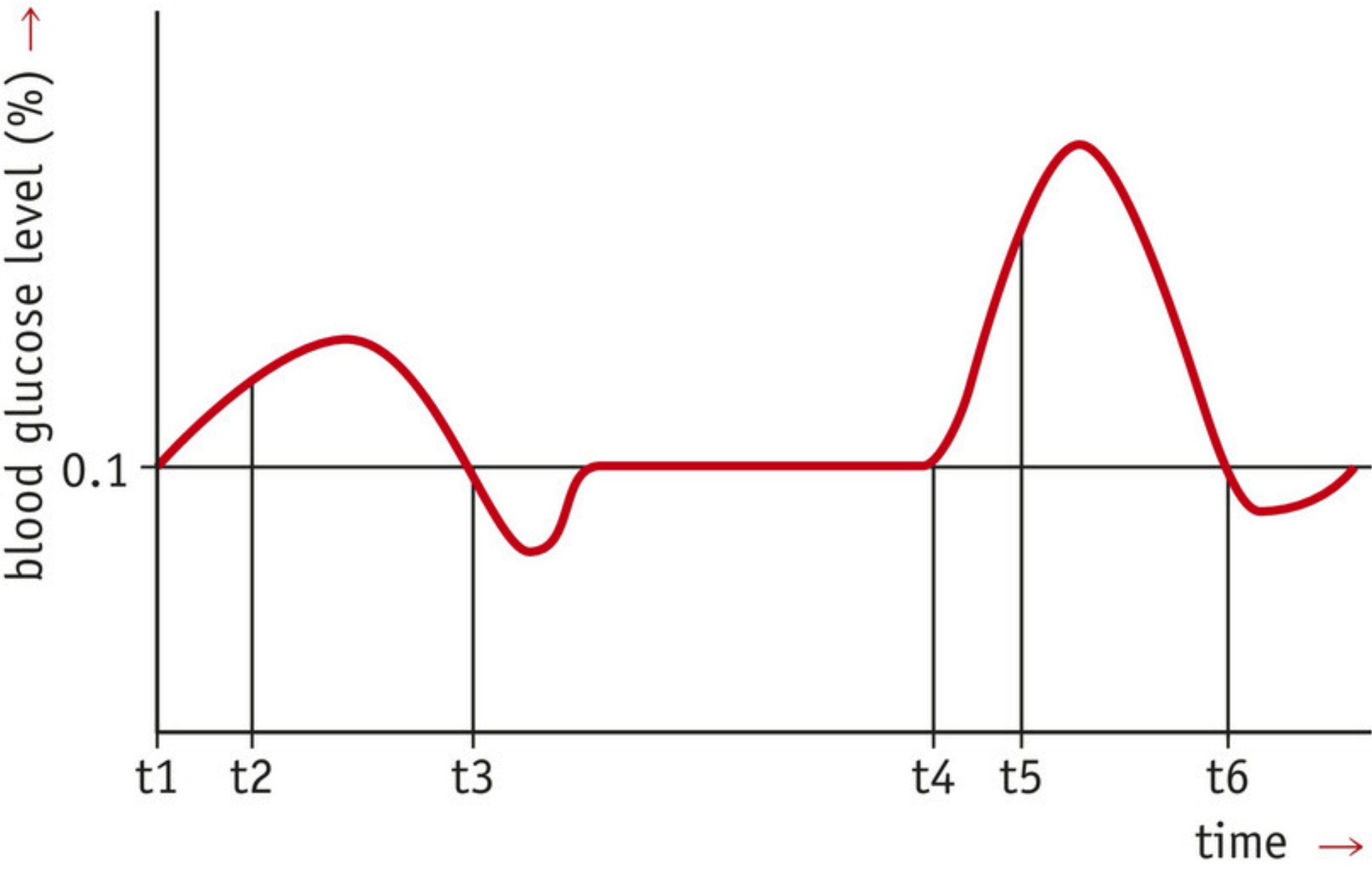


fig. 17 Two meals.



1 white bread with jam

2 salad with vegetables

+ 10

Table 1 gives the nutritional values for three types of bread. If you eat wholemeal bread instead of white bread, less carbohydrates are stored as food reserves. That is because wholemeal bread contains less carbohydrates than white bread, but there is an even more important reason. What reason is that? Explain your answer.

Table 1 Nutritional value of bread.

	Brown bread	Wholemeal bread	White bread
Energy (kcal)	236	234	247
Fats (g)	1.7	2.3	1.6
Carbohydrates (g)	43	39	48
Dietary fibre (g)	5	6.7	2.5
Protein (g)	10	11	9
Salt (g)	1	1	1

HOW IT FITS TOGETHER the world we live in

NUTRITION DURING PUBERTY

Boys in particular can start eating a lot during puberty, but they do not get fat. Explain why. This is not just because of the growth spurt (in height) that both boys and girls undergo. Boys are mainly producing extra muscular tissue. A 16-year-old boy has on average twelve to thirteen kilograms more muscle than a girl of the same age. Girls gain more fat in their breasts, hips and thighs during puberty. Boys' muscles need much more energy than the fat reserves that girls build up under the skin. "Muscles are always under tension – they are almost never completely relaxed," says Jaap Seidell, professor of Nutrition and Health of VU University of Amsterdam. "That's why boys and girls have such different energy requirements."

Source: *De Volkskrant*, 'Waarom worden tienerjongens niet dik, ook al eten ze veel?' ("Why don't teenage boys get fat even though they eat a lot?"), May 2017

fig. 18



11

Read the text "Nutrition during puberty".

- a Boys in particular have to eat food rich in protein during the growth spurt in puberty. Explain why.
- b The recommended daily allowance (RDA) for calcium for young people aged between 12 and 16 is 1150 mg according to the Netherlands Nutrition Centre.
A milk carton states that 100 mL milk contains 120 mg calcium and that this is 15% of the RDA for calcium.
Is the RDA for calcium on this milk packaging right for boys in this age group? Explain your answer using a calculation.
- c Adolescents need more calcium and vitamin D in their food than adults. Explain why.

 Go to the *Flash cards* and the *Test yourself* section.

2 The digestive system

LEARNING OBJECTIVES

- 2.2.3 You can describe the functions of digestion, digestive juices and enzymes.
- 2.2.4 You can list the parts of your dentition and their functions.
- 2.2.5 You can describe the function of peristalsis and how it works.
- Practical activities 4 and 5

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES			
	2.2.3	2.2.4	2.2.5	2.1.1*
Remembering		2a		
Understanding	1, 4	2b, 4	3, 4	
Using	5a, 6	10a		
Analysing	5b, 9a, 10e	10b	7, 8, 9ab, 10cd	7, 9ab

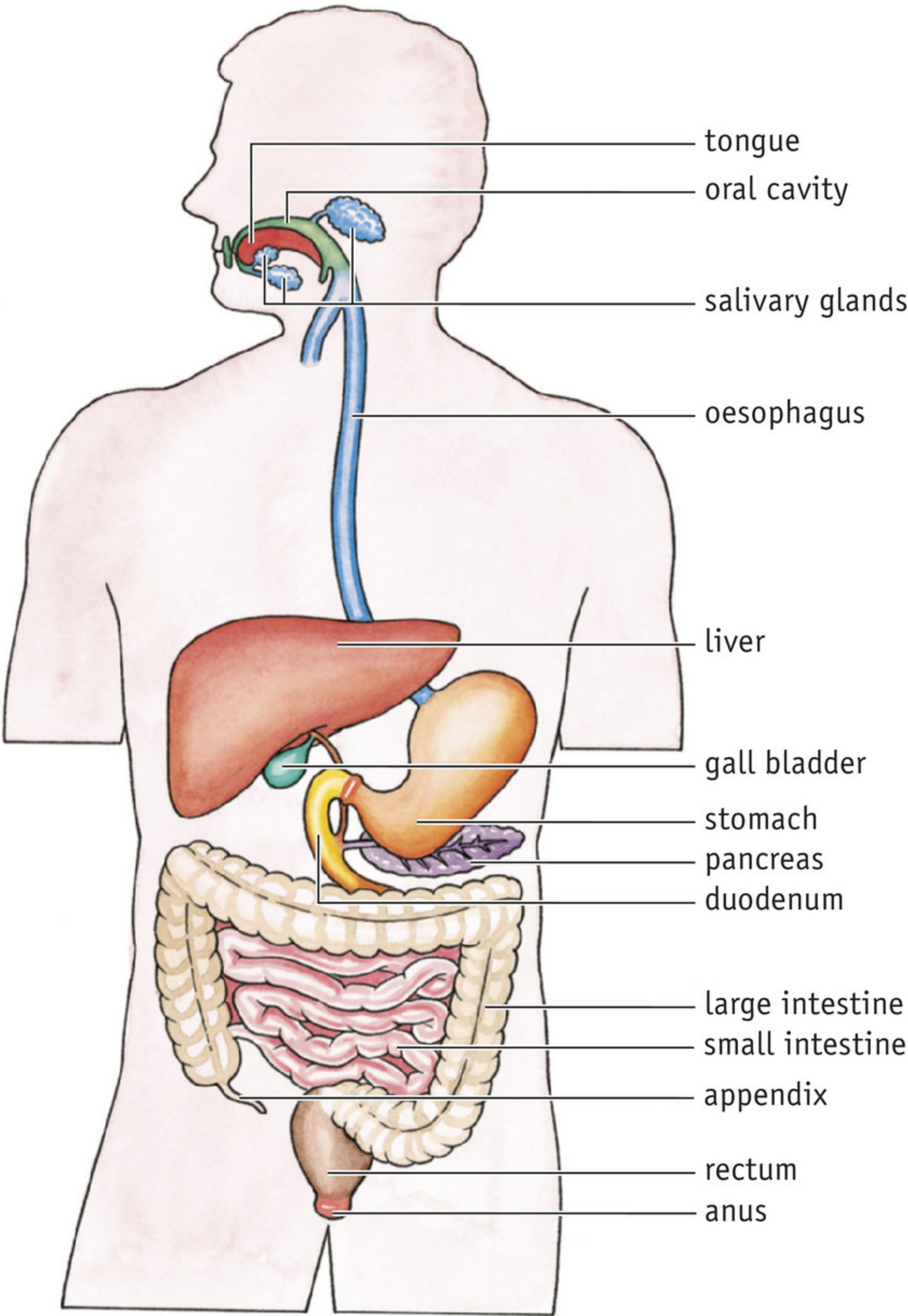
* You can find this learning objective in another Basics section.

Your body needs nutrients so that it can function. Before your cells can absorb the nutrients, the food needs to be digested. The digestive system does that.

DIGESTION

Figure 1 shows a diagram of the human **digestive system**. The digestive system consists largely of a long piece of tubing from the mouth to the anus: the **intestinal tract**.

fig. 1 The human digestive system.



The digestive system is where nutrients from the food are absorbed into the bloodstream. Some foodstuffs can pass through the wall of the intestines and be taken up into the blood. Examples are glucose, minerals, water and vitamins. These substances do not have to be digested first. Other nutrients cannot pass through the intestinal wall. Examples are proteins, most carbohydrates (such as sugars and starches) and fats. These nutrients have to be digested first.

During **digestion**, larger nutrient molecules are broken into smaller **digestion products** that can pass through the intestinal wall and be absorbed into the bloodstream. The breakdown is done in two steps:

- breaking the food up into smaller pieces by chewing
- converting the nutrients using digestive juices

CHEWING

Food goes in your mouth first. You have probably noticed that you have different kinds of teeth. The **incisors** and **canines** are used for cutting off pieces of food. In humans, the canines are only a little bit more pointed than the incisors (see figure 2). **Molars** have a knobby top surface. This lets you grind the food up small between the molars. This breaks your food down into small pieces, making it easier to swallow. Chewing also has a digestive function: Because the food has been broken into little pieces, the surface area is larger (see figure 3). This is known as **mechanical digestion**.

fig. 2 The teeth.

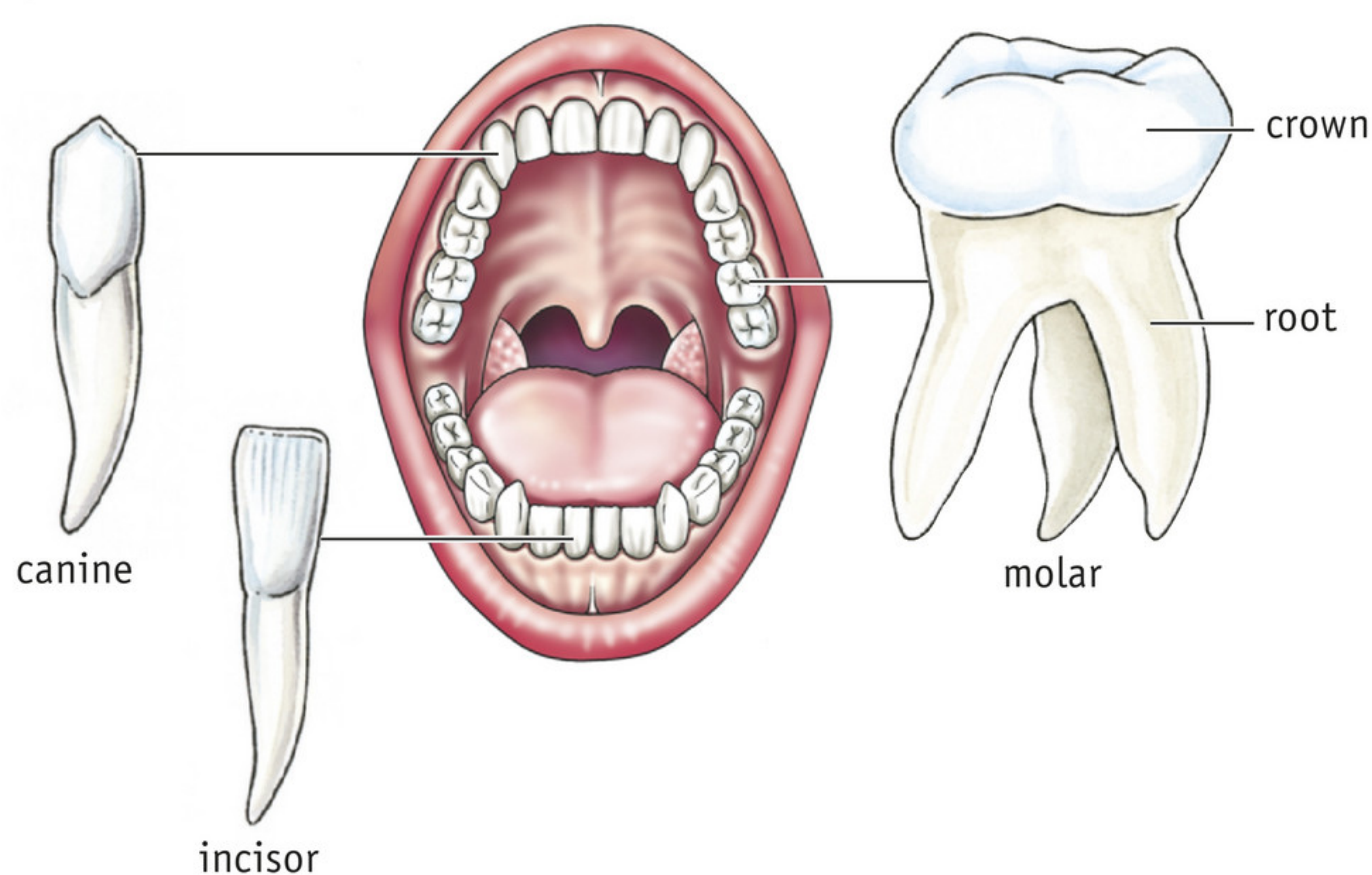
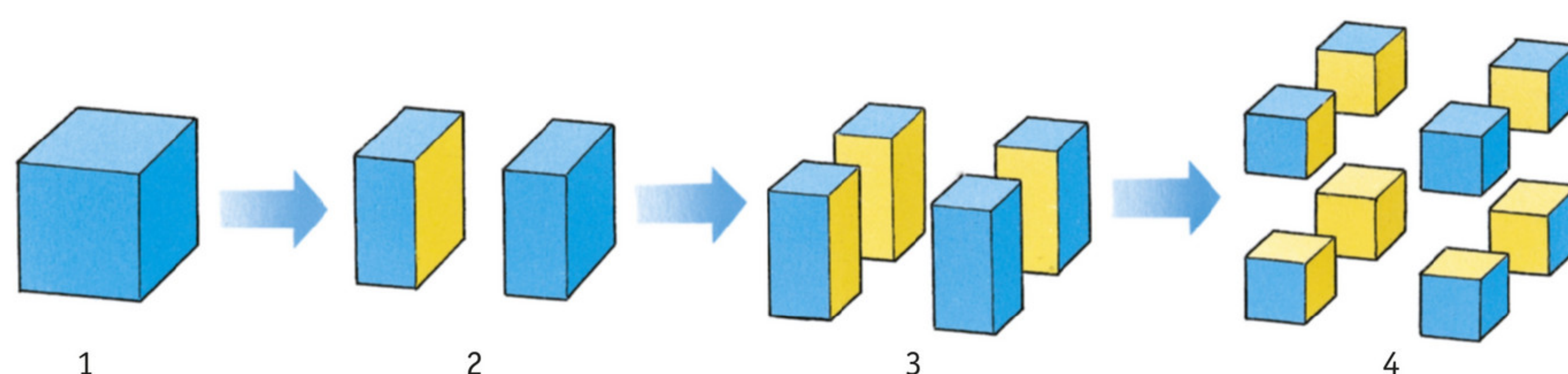


fig. 3 Increasing the surface area (yellow) by chewing.



DIGESTIVE JUICES

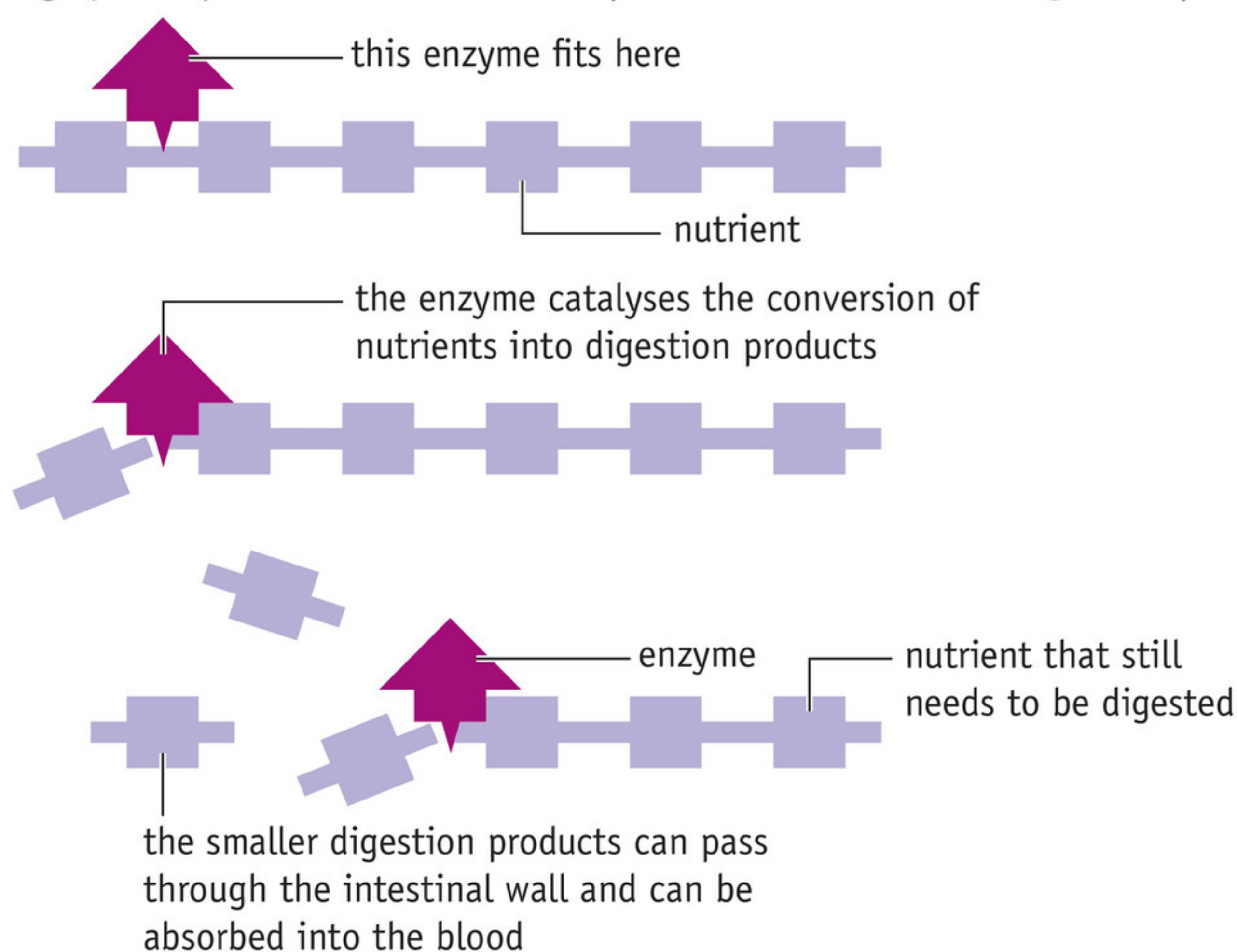
Digestion is done using **digestive juices**. Saliva and gastric juice are examples of digestive juices. Digestive juices are made by the **digestive glands**. Human digestive glands are:

- the salivary glands
- the gastric glands
- the liver
- the pancreas
- the intestinal glands

The digestive juices make sure that the substances in your food are broken down into smaller and smaller substances (digestion products). Chemical reactions take place: substances are converted into other substances. This part of the digestive process is therefore called **chemical digestion**.

Many digestive juices contain **enzymes**. Enzymes are substances that speed up chemical reactions (see figure 4). The enzymes in digestive juices help break down the substances in your food. Chewing your food increases its surface area. The enzymes in the digestive juices are then able to act on a larger food surface area. This lets the enzymes get at the nutrients in the food more easily.

fig. 4 Enzymes can be used to help convert nutrients into digestion products.



PERISTALSIS

Along the wall of the whole intestinal tract, there are **circular muscles** (sphincter muscles) and **longitudinal muscles** (see figure 5). These muscles contract and relax alternately, pushing the food forward through the intestines, kneading it and mixing it thoroughly with the digestive juices too on the way. The term for these movements of your intestinal wall is **peristaltic movements** or **peristalsis**.

Figure 6 shows you how peristalsis works. Just behind a lump of food, the longitudinal muscles relax and the circular muscles contract. That makes the intestinal tract narrower at that point, 'pushing' the food forward. Just in front of the lump of food, the longitudinal muscles contract and the circular muscles relax. This lets the food move forwards. Dietary fibre stimulates the muscles in the intestinal wall, ensuring proper intestinal function.

fig. 5 Circular muscles and longitudinal muscles.

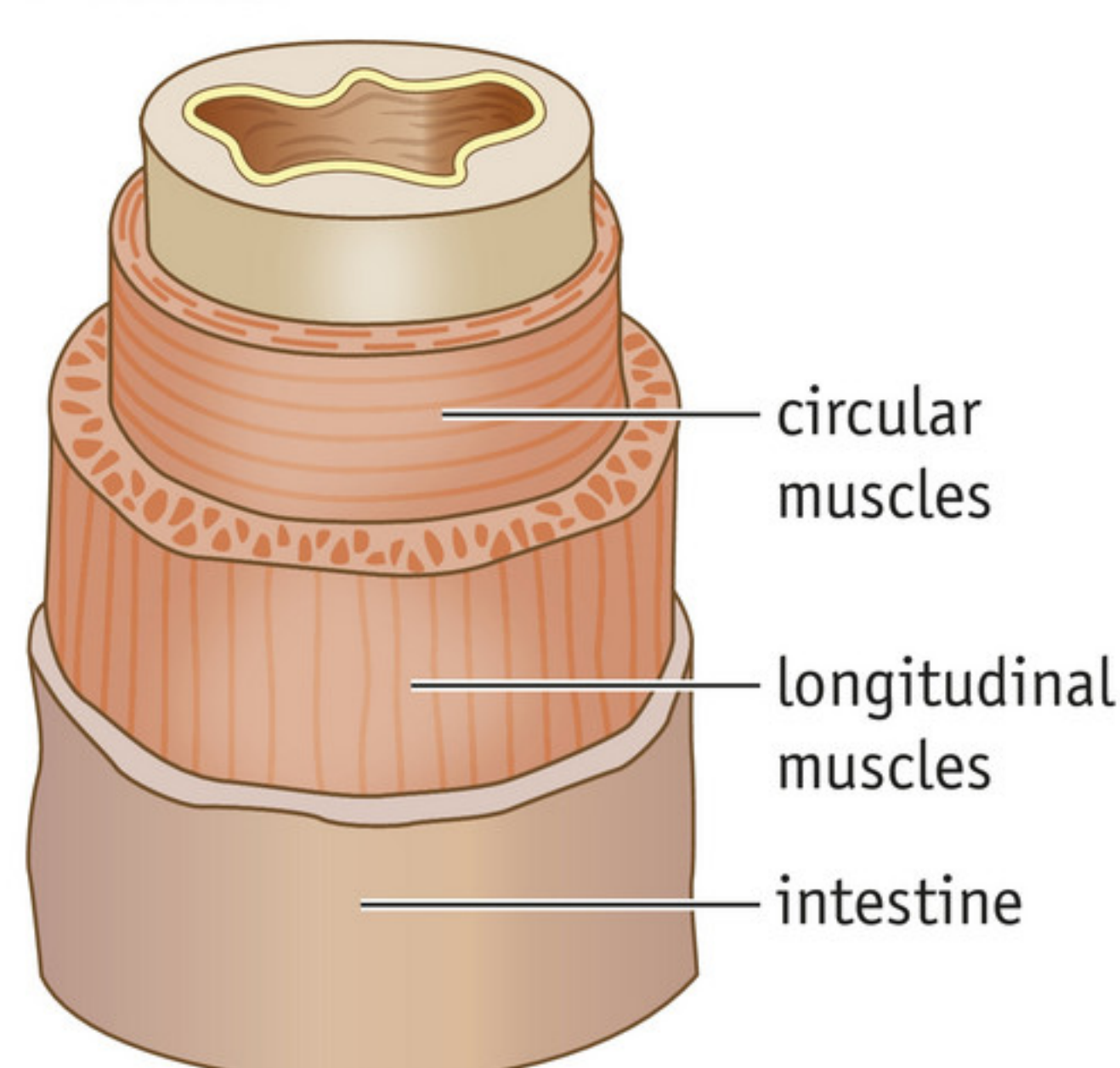
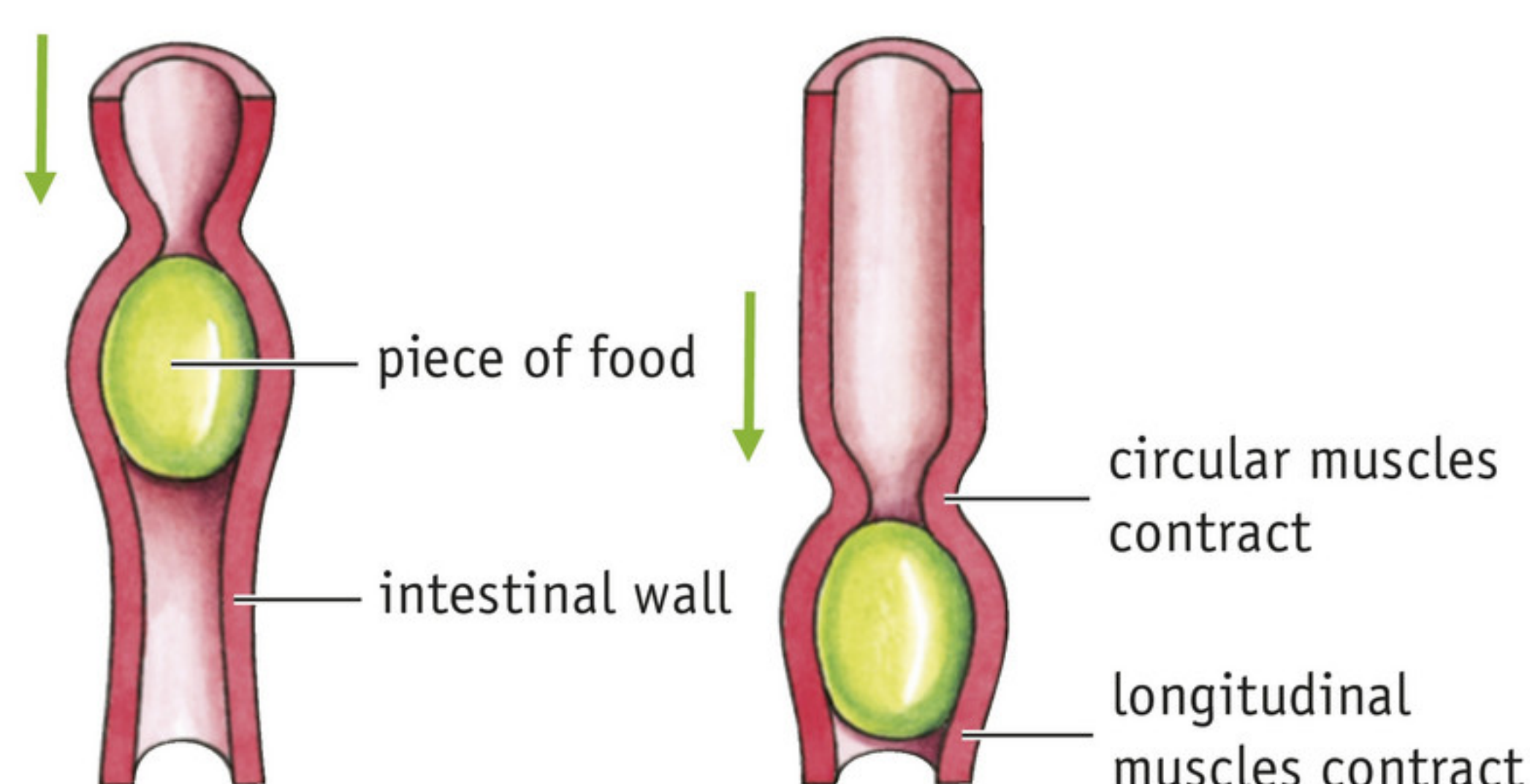


fig. 6 Peristalsis.



KNOWLEDGE

1

Nutrients that cannot pass through the intestinal wall need to be digested first.

- What substances have to be digested first before they are absorbed into the blood?
proteins / glucose / minerals / fats / starch
- Digestive juices are used in *chemical / mechanical* digestion.
- Chewing food is part of the *chemical / mechanical* digestion process.
- Digestive enzymes are part of the *chemical / mechanical* digestion process.
- Enzymes *slow down / speed up* digestion.

2

a What shapes and functions do the various teeth have?

- | | | |
|--|-----------------------|--|
| A function of the molars | ☐ | ☐ 1 grinding food up |
| B function of the incisors and canines | ☐ | ☐ 2 a bit more pointed than incisors |
| C the shape of the canines | ☐ | ☐ 3 knobbly face |
| D shape of the molars | ☐ | ☐ 4 bite off bits of food |

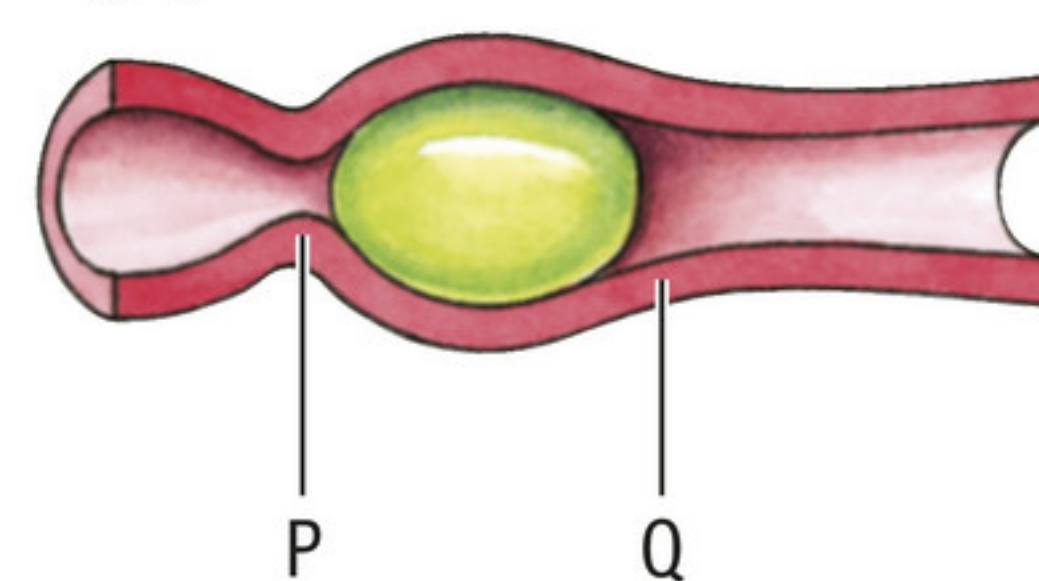
b The function of the teeth is breaking food up into smaller pieces.
What two benefits does it have for further digestion?

3

Figure 7 shows a section of the intestines with a piece of food. Peristaltic movement pushes the piece of food through.

- a**
- At position P, the *circular muscles / longitudinal muscles* contract.
 - They make the intestines *narrower / wider*.
 - At position Q, the *circular muscles / longitudinal muscles* contract.
 - The lump of food is moved from *P to Q / Q to P*.
- b** Dietary fibre has an influence on the digestion of food. Put these events in the correct sequence.

fig. 7



- This lets many enzymes work on the chyme (food pulp) at once.
- This mixes the food pulp well with the digestive juices.
- The digestion of food is speeded up.
- Dietary fibre stimulates peristalsis.

4



Summary Digestion

- The function of digestion is
- Nutrients that get digested are
- Substances that do not need to be digested are
- Mechanical digestion is
- Chemical digestion is
 - Digestive juices are made by the
 - Many digestive juices contain

Teeth

- The function of the teeth is
 - This
 - This
- The function of incisors and canines is
 - The shape of canines is
- The function of molars is
 - The shape of molars is

Peristalsis

- How it works:
- Function:
- Dietary fibre:

INSIGHT

5

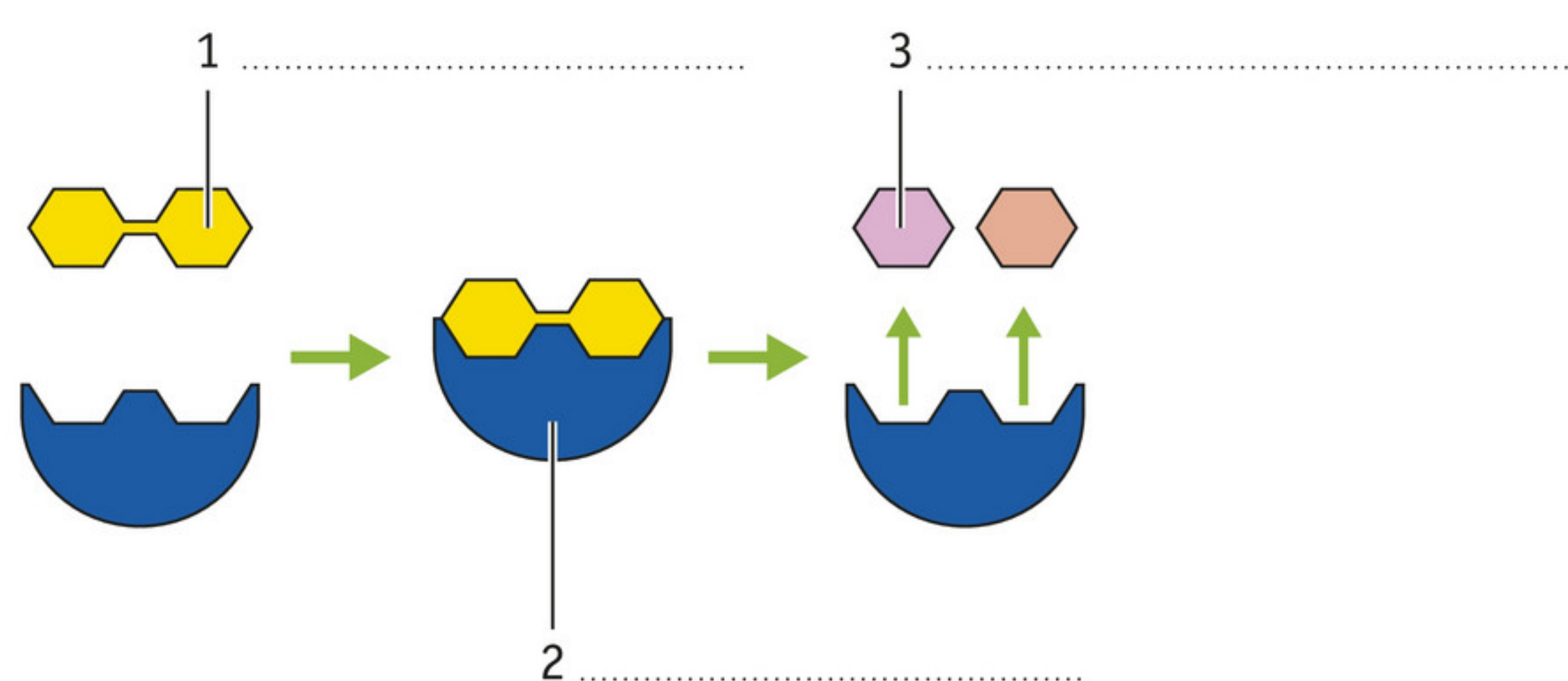
Figure 3 shows how the total surface area increases when you divide a cube into pieces. A cube has six faces. The edges of the cube in drawing 1 are 2 cm long.

- How many times larger is the total surface area in drawing 4 than the surface area in drawing 1? Include a calculation with your answer.
- Explain why figure 3 shows that food is digested better if you chew it thoroughly.

6

- What process can you see in figure 8?
- Write down the names of the numbered parts in figure 8.

fig. 8



7

Many people want to eat less animal products and therefore buy vegetarian products (see figure 9).

Explain why digestion may go more quickly if you eat vegetarian 'meatballs' instead of beef ones.

fig. 9 Meat and meat substitutes.



1 meatballs made of beef



2 vegetarian 'meatballs'

8

Can food or drink in your mouth get to your stomach if you are hanging upside down? Explain your answer.

+ 9

In excretion, substances that have been absorbed into the blood or the cells are removed from the body. Carbon dioxide is eliminated through the lungs, for instance.

- a** Does the body excrete dietary fibre (other than by defecation)? Explain your answer.
- b** Is dietary fibre an internal stimulus or an external stimulus for the intestines? Explain your answer.

HOW IT FITS TOGETHER the world we live in

STONES IN THE STOMACH

It may not sound pleasant to have rocks in your stomach, but it is common in birds. Not smooth pebbles either: preferably sharp stones. That needs a special stomach: the gizzard. The wall of the gizzard has a thick layer of muscle. The birds use the muscle bundles and sharp stones in the gizzard to grind food and mix it with digestive juices. The digestive juice comes from another stomach: the glandular stomach. The glandular stomach is in front of the gizzard and adds acid and digestive juices to the food that has been swallowed. In birds of prey, the gizzard has another special function. The little owl, for example, swallows its prey whole (see figure 10.1). The indigestible parts, such as the bones, are kneaded in the gizzard and pressed into pellets. That is why you can find parts of the skeleton of prey animals in the pellets regurgitated by little owls and barn owls (see figure 10.2). In other birds of prey, such as long-eared owls, the glandular stomach secretes a much stronger acid. As a result, you find very few prey bones.

fig. 10



1 Little owl with frog it has caught



2 Pellet with bones

10

Read the text 'Stones in the stomach'.

- a** Birds often have stones in their stomachs, unlike humans. Explain this using the anatomy of birds.
- b** The muscle layer in the wall of the gizzard is much thicker than the muscle layer in the stomach walls of humans. What human muscles (other than the stomach muscles) have the same function as the muscles in the gizzards of birds? Explain your answer.
- c** Explain why you find far fewer skeleton parts in the pellets of long-eared owls than in the pellets of little owls.
- d** Explain why the peristaltic movements in owls must also be able to go in the other direction.
- e** Is chemical digestion in birds also accelerated by mechanical digestion? Explain your answer.

3 The digestive organs

LEARNING OBJECTIVES

2.3.6 You can list the functions and characteristics of the parts of the digestive system.

► Practical activity 6

2.3.7 You can list the digestive juices and their functions.

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES					
	2.3.6	2.3.7	2.1.1*	2.1.2*	2.2.3*	2.2.5*
Remembering	2	3				
Understanding	1, 4	4				
Using	5a, 8ab	5bc, 6a, 8ab, 10a	10ac	10c		10a
Analysing	6b, 7, 8cd, 9, 10d	8cd, 9, 10bd	8d, 9	9	7	

* You can find this learning objective in another Basics section.

The organs of the digestive system are mostly in the abdomen. Important organs for digestion are the oesophagus, stomach, liver, small intestine and large intestine.

ORAL CAVITY, PHARYNX AND OESOPHAGUS

The digestion of food starts in your oral cavity. Your salivary glands (see figure 1) produce **saliva**, a digestive juice that consists of water, mucus and an enzyme. The mucus makes the food more slippery, so that swallowing it is easier. The enzyme in saliva is for digesting starch. This means that some of the starch in your food is already being digested in your mouth.

fig. 1 The locations of the salivary glands.

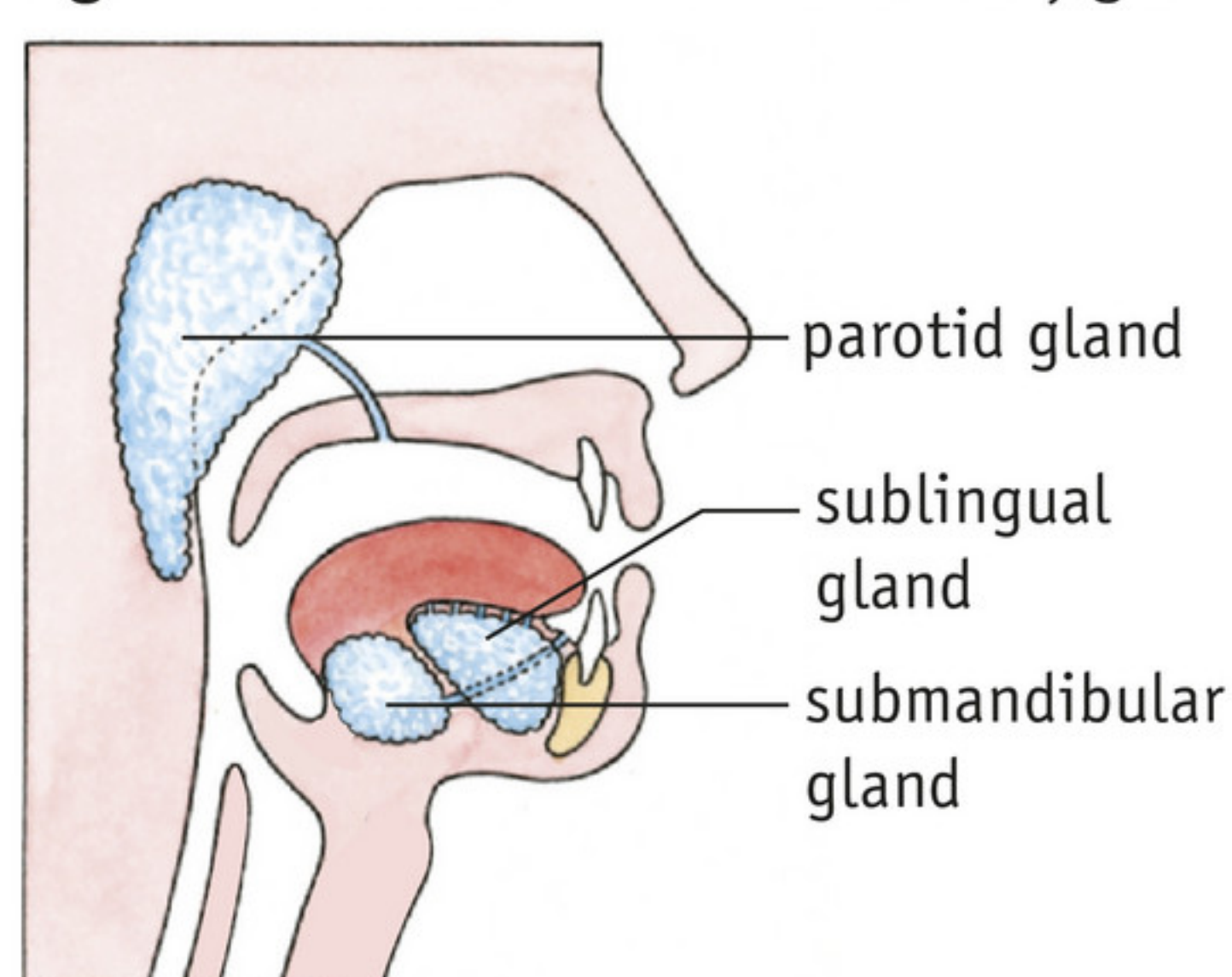
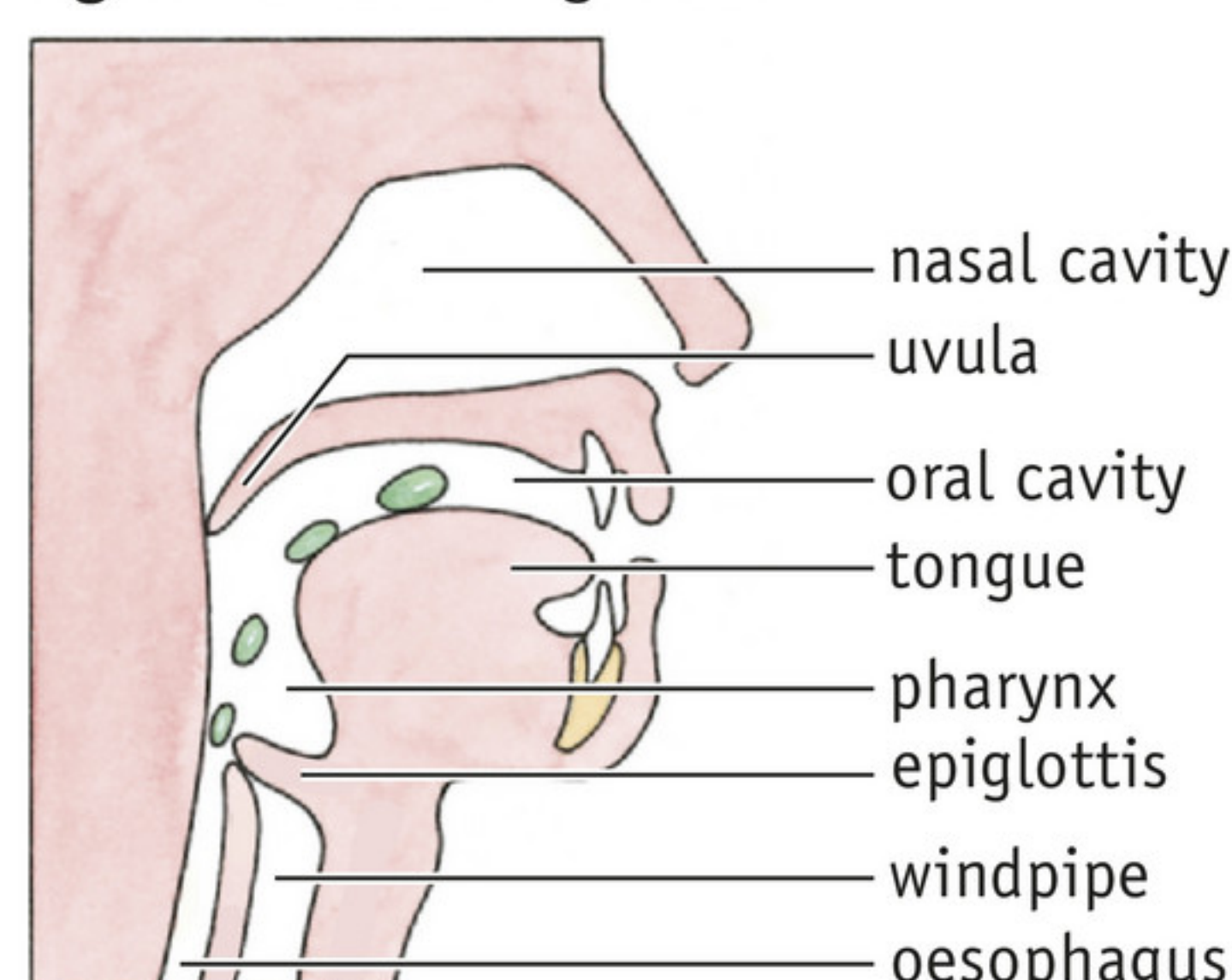


fig. 2 Swallowing food.



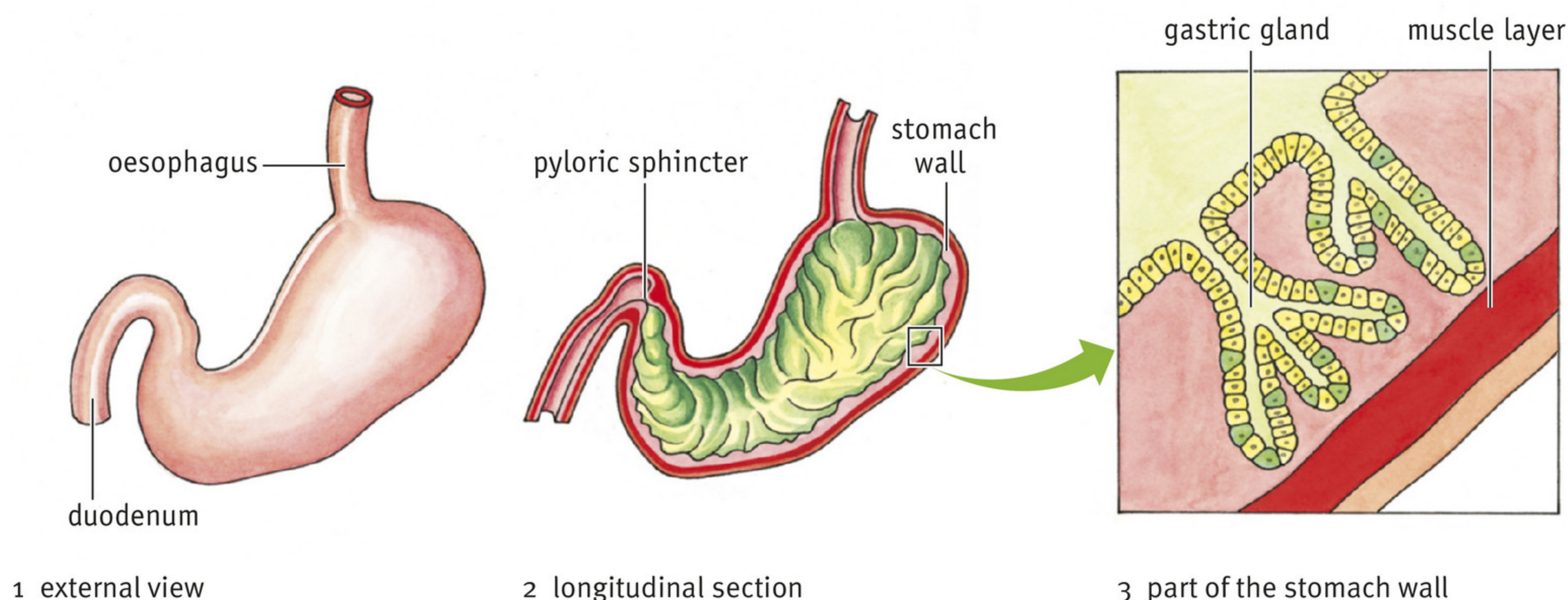
You use your tongue to move the food from the oral cavity towards the pharynx (throat). Swallowing your food pushes it into the **oesophagus** (gullet). When you swallow, the nasal cavity is automatically closed off by the uvula and the windpipe is closed off by the epiglottis (see figure 2). The food is then only able to go down the oesophagus.

STOMACH

Peristalsis in the oesophagus pushes the food towards your stomach. The stomach wall also has circular muscles and longitudinal muscles. Because these muscles contract and relax alternately, your **stomach** is almost constantly moving. This kneads the food and mixes it with digestive juices from the stomach wall (see figure 3). **Gastric glands** in this wall produce **gastric juice**. Gastric juice consists of water, hydrochloric acid and an enzyme. The hydrochloric acid kills any bacteria in your food. The enzyme in the gastric juice partially digests the proteins in your food.

At the end of your stomach, there is a circular muscle that can close off the exit from it: the **pyloric sphincter**. Each time it opens, this muscle lets just a small amount of food through to the duodenum. This means that the stomach also has a role as temporary storage for food.

fig. 3 The stomach.



DUODENUM, LIVER, GALL BLADDER AND PANCREAS

Food gets into the **duodenum** via the pyloric sphincter (see figure 4). In this part of the intestines, digestive juices from the liver and the pancreas are added to the food. The **liver** produces **bile**, which is stored temporarily in the **gall bladder**. Bile is passed from there to the duodenum through the **bile duct** when it is needed. The gall bladder is therefore not a gland: it is just a storage place.

Fats do not mix with water but create large droplets instead. Bile breaks large droplets of fat up into smaller ones (see figure 5). This is called **emulsification**. Emulsification increases the surface area of the fat droplets a great deal, making it easier for the enzymes to access the fats and thereby letting them digest the fats faster. Bile does not digest fats: it only emulsifies them.

The **pancreatic juice** from the **pancreas** has various enzymes that digest proteins, carbohydrates and fats.

fig. 4 The location of the stomach, duodenum, liver, gall bladder and pancreas.

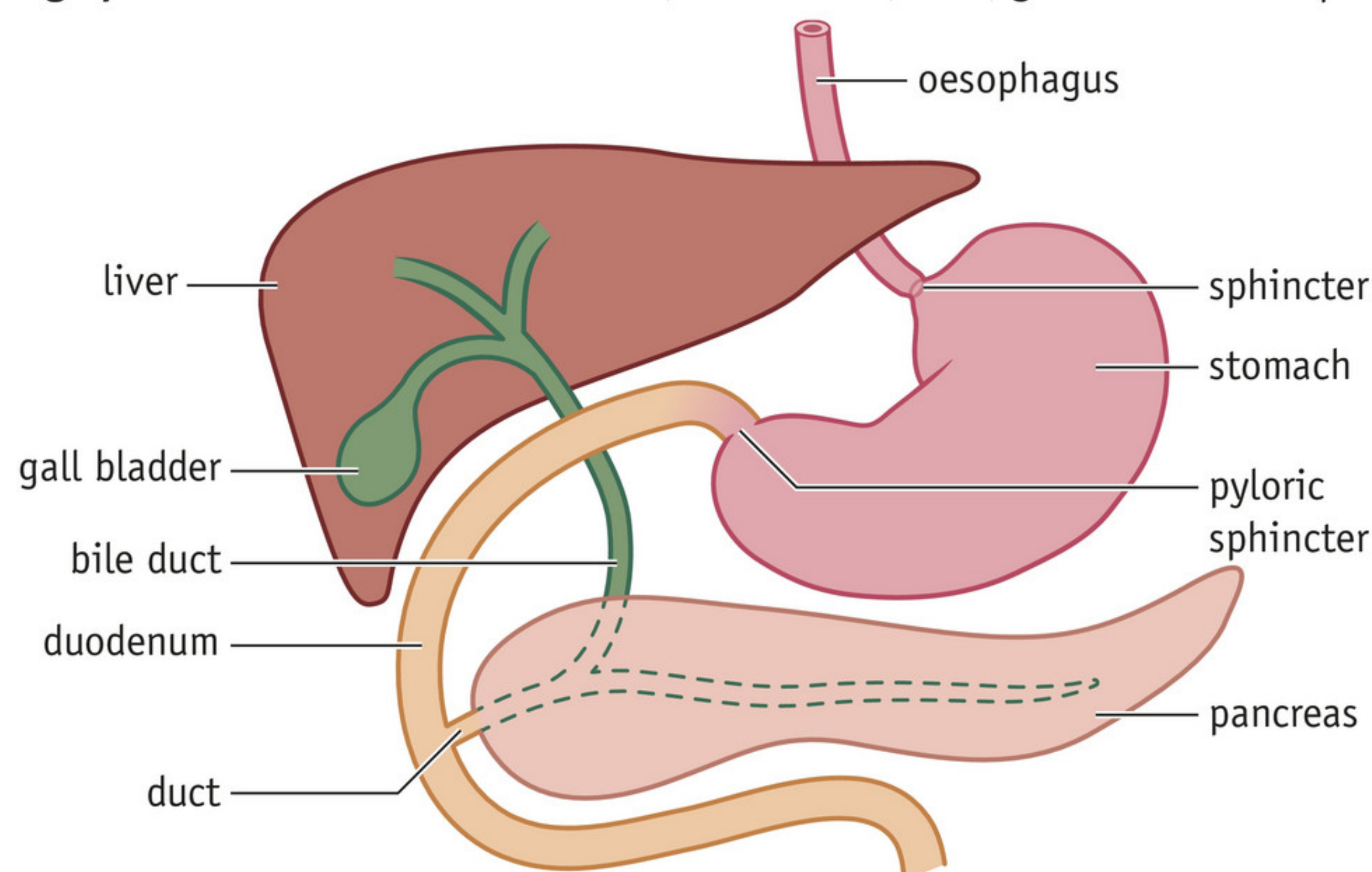
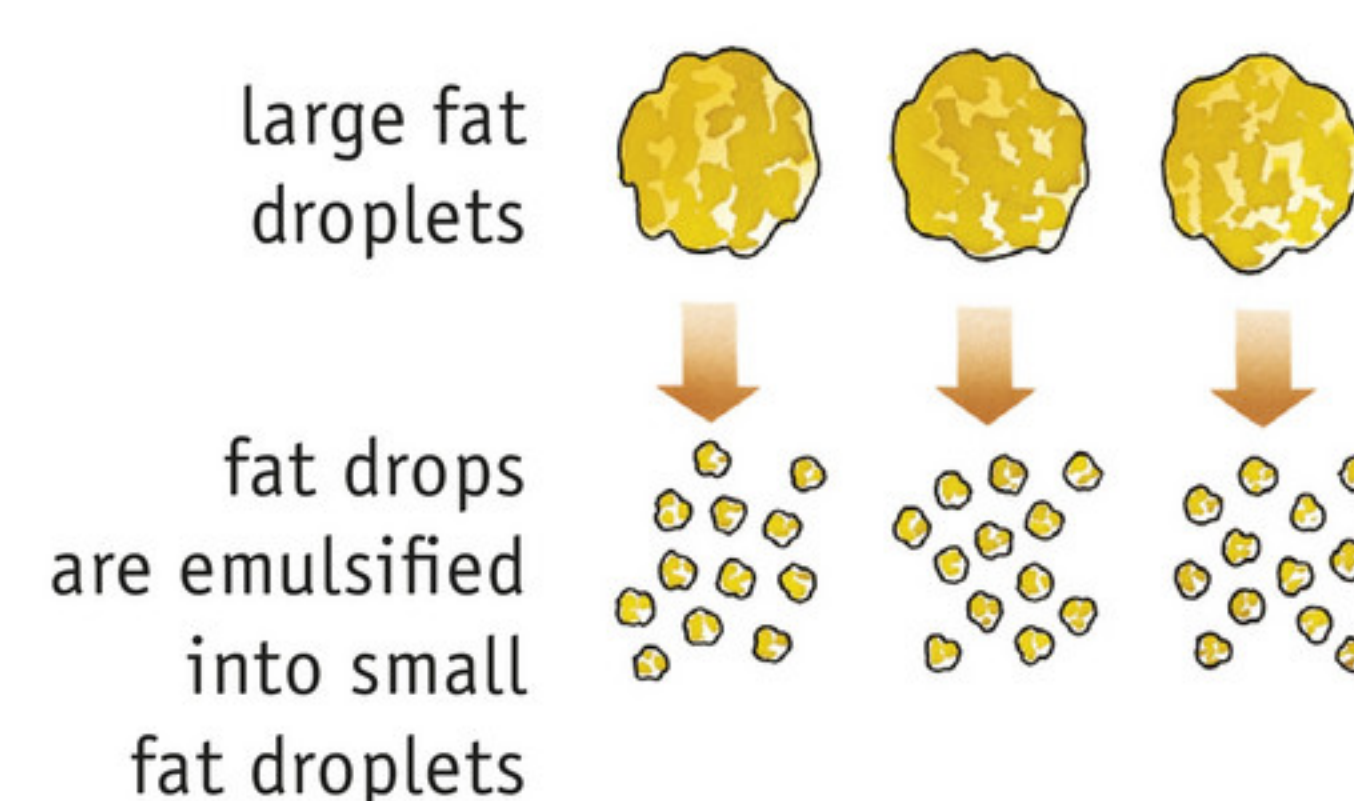


fig. 5 Bile emulsifies fats.



SMALL INTESTINE

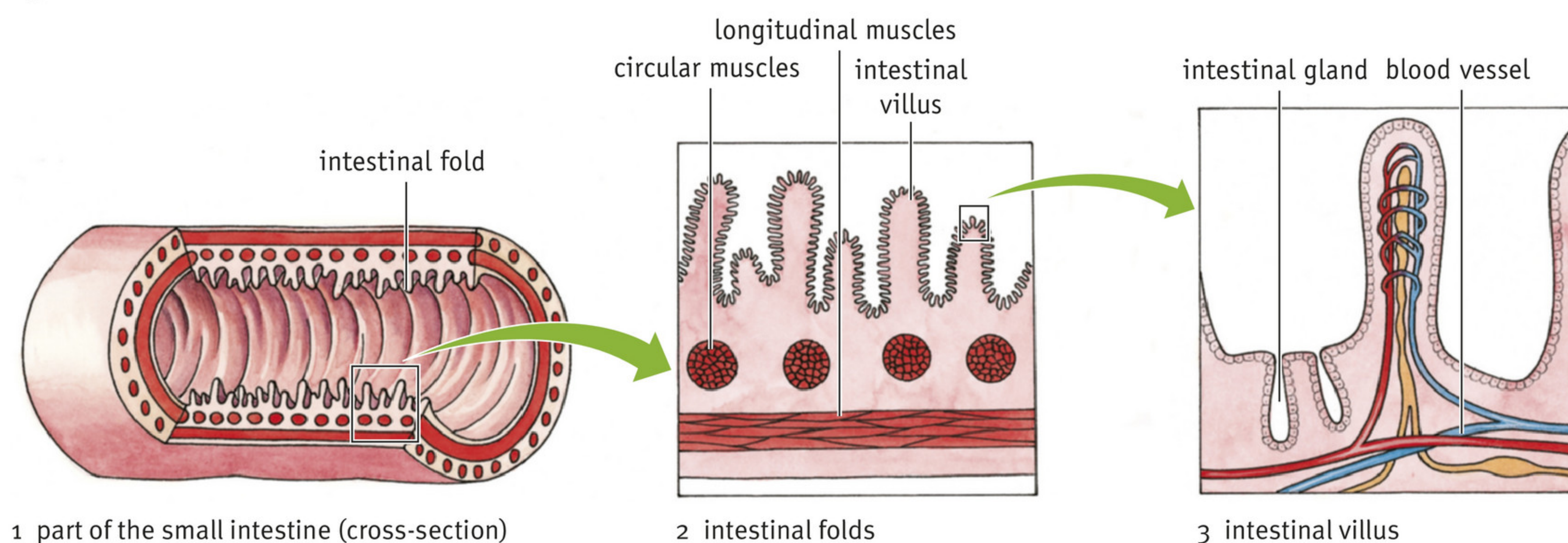
In humans, the **small intestine** is about 6 metres in length. This long intestine lies in twists and coils inside the abdomen. The wall contains **intestinal glands** that secrete **intestinal juices** (see figure 6). Intestinal juice contains enzymes that complete the digestion of proteins and carbohydrates. The digested substances can then be absorbed into the blood through the intestinal wall.

In the intestinal tract (from the oral cavity to the small intestine), various digestive juices are added to the food. The digestive juices contain a lot of water. As a result, the food pulp now also has a lot of water. Nutrients and digestion products are dissolved in it. The water containing the nutrients and digestive products is absorbed into the blood in the small intestine. This happens through the intestinal wall.

The wall of the small intestine is very convoluted – it has lots of folds (see figure 6). The **intestinal folds** in turn have protrusions called the **intestinal villi**. The intestinal folds and villi give the intestinal wall a large surface area.

The intestinal villi have blood vessels and their walls are very thin. This means that water containing dissolved nutrients and digestion products can be absorbed there into the blood. The large surface area of the intestinal wall increases the speed at which substances are absorbed. The blood transports the absorbed substances to the body's cells.

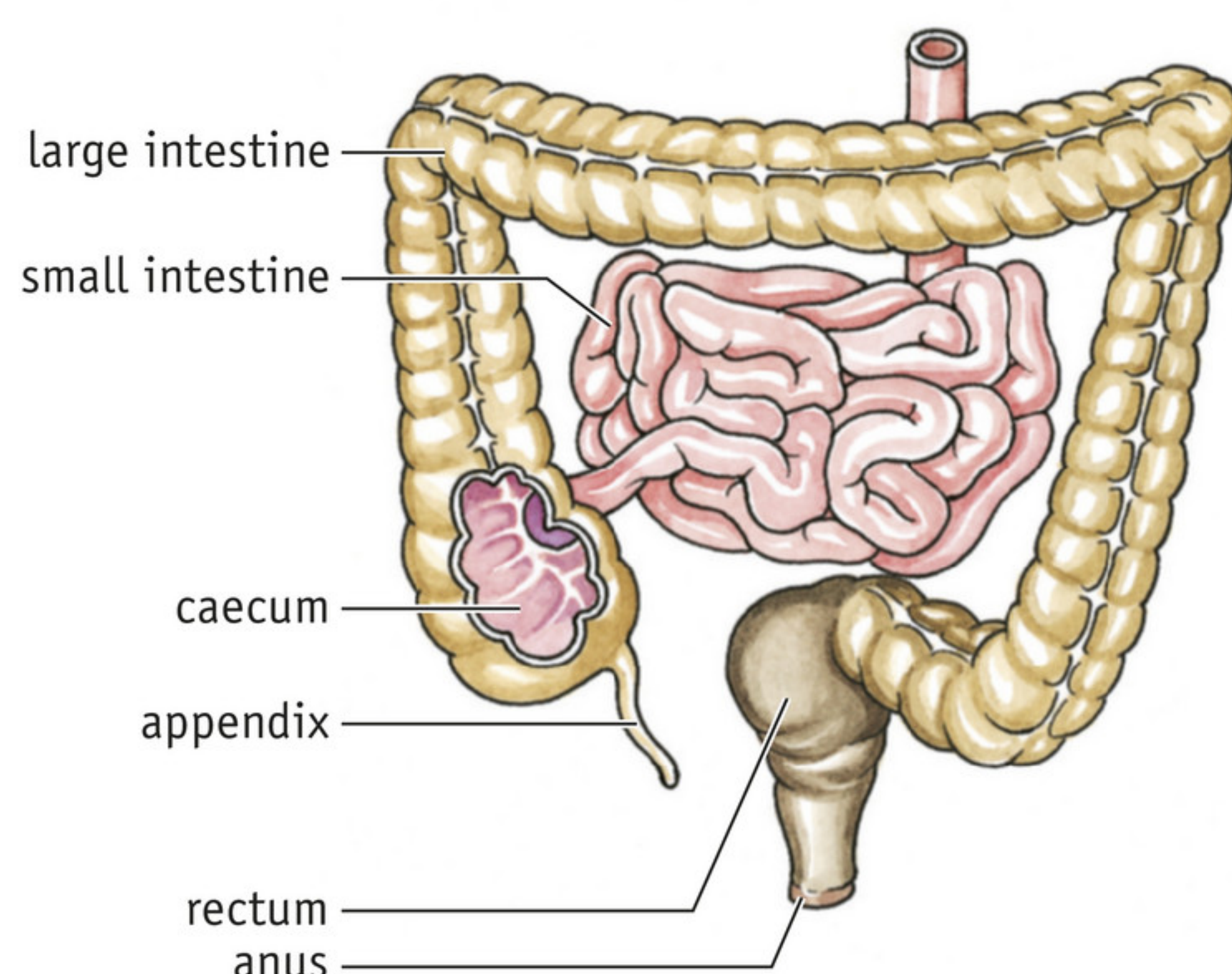
fig. 6 The structure of the small intestine.



LARGE INTESTINE, CAECUM AND RECTUM

The small intestine goes into the **large intestine** (see figure 7). Just below this transition is the **caecum**. The caecum does not have its own digestive function. At the bottom of the caecum is a small protrusion called the **appendix** (or vermiform appendix in full). This is the part that is inflamed in appendicitis. It may then be surgically removed, but the caecum is left in place.

fig. 7 Small intestine (reduced in size), large intestine, caecum and rectum.



The large intestine is about one and a half metres long. Undigested food residues are passed from the small intestine into the large intestine. This pulp still contains a lot of water. Almost all the water is absorbed into the blood through the wall of the large intestine. The pulp of food residues becomes thicker. If that does not happen sufficiently, you will get diarrhoea. You lose a lot of fluid then and can become dehydrated.

The cell walls of food obtained from plants contain cellulose. This carbohydrate is difficult for humans to digest because their digestive juices do not contain an enzyme that is capable of breaking cellulose down. However, numerous bacteria live in your large intestine that produce an enzyme that can do that. This means that some of these plant food residues are digested in the large intestine after all. The digestive products of cellulose include glucose, which is partly absorbed into the bloodstream.

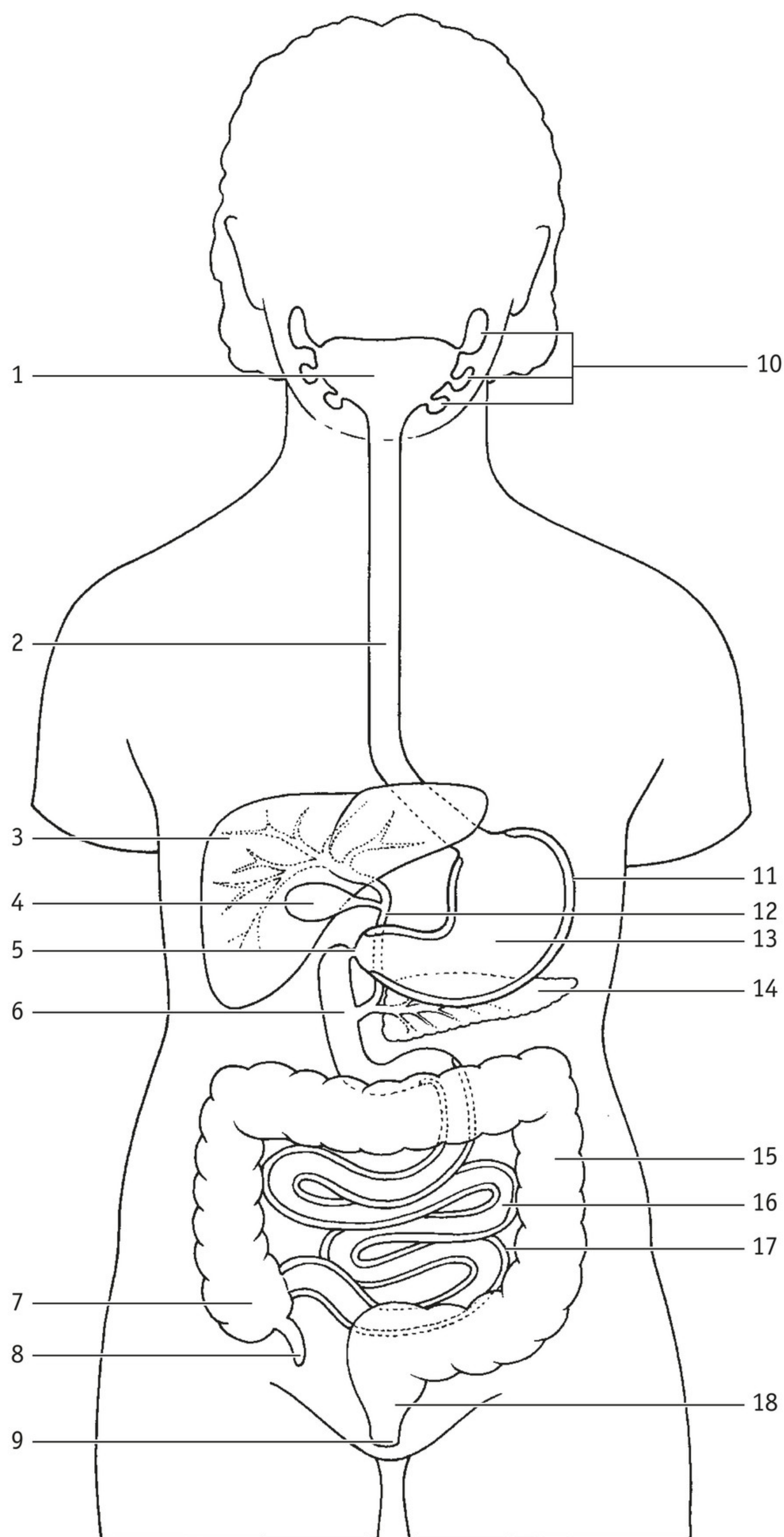
Peristalsis moves the thickened, undigested food residues to the **rectum**, where they are stored temporarily. The intestinal tract is closed off by a circular muscle or sphincter, the **anus**. From time to time, this sphincter can be relaxed and the rectum is emptied. This is called a **bowel movement** (stool defecation).

KNOWLEDGE

1

Write down the names next to the numbered parts in figure 8. Enter the names of the digestive glands at 10, 11 and 17.

fig. 8 The digestive system.



- 1 = ...
 2 = ...
 3 = ...
 4 = ...
 5 = ...
 6 = ...
 7 = ...
 8 = ...
 9 = ...
 10 = ...
 11 = ...
 12 = ...
 13 = ...
 14 = ...
 15 = ...
 16 = ...
 17 = ...
 18 = ...

2

Which part of the digestive system belongs with which function?

- | | | |
|---|-----------------------|---|
| A producing pancreatic juice | ☐ | ☐ 1 pancreas |
| B mixing bile and pancreatic juices with the chyme (food pulp) | ☐ | ☐ 2 large intestine |
| C producing bile | ☐ | ☐ 3 small intestine |
| D producing saliva | ☐ | ☐ 4 rectum |
| E collecting and providing temporary storage for undigested food residues | ☐ | ☐ 5 liver |
| F absorbing nutrients, digestion products and water into the blood and producing intestinal juice | ☐ | ☐ 6 stomach |
| G temporary storage of the food | ☐ | ☐ 7 oral cavity (mouth) |
| H moving food from the pharynx to the stomach | ☐ | ☐ 8 oesophagus |
| I removing water from the pulp of undigested food residues and absorbing water into the blood | ☐ | ☐ 9 duodenum |

3

Complete the table.



Digestive juices	Produced by	Contains enzymes for digesting	Other functions
Saliva			
Gastric juice			
Bile		–	
Pancreatic juice			–
Intestinal juice			–



Put the parts in the right order and describe what happens in each part: *pancreas* – *large intestine* – *small intestine* – *rectum* – *liver* – *stomach* – *oral cavity* – *oesophagus* – *duodenum*.

5

- What lets the stomach act as a temporary storage place for food?
- Why do fewer bacteria live in the duodenum than in the large intestine?
- Using the data in table 1, work out how many litres of water leave the stomach per day on average.

..... L leaves the stomach per day.

Fluid	Quantity
Pancreatic juice and intestinal juice	about 2.5 L
Food and drink	about 2 L
Gastric juice	about 1.5 L
Juices from the liver	about 1 L
Saliva	about 1 L

6

The liver produces the digestive juice called bile (sometimes also called ‘gall’). A pupil is studying the effect of bile on the fat content of milk (see figure 2). At the start of the study, the fat content in the milk in each beaker is 3.5%.

a What percentages of fat do you expect after three hours?

- A beaker 1

☐

☐

1 0.5%
- B beaker 2

☐

☐

2 2.0%
- C beaker 3

☐

☐

3 3.5%

b In someone with cystic fibrosis, the body produces a lot of thick mucus. This can block the outgoing ducts in parts of the digestive system. In a patient with cystic fibrosis, the faeces contain a lot of fat.
Which ducts of the digestive system may be blocked?

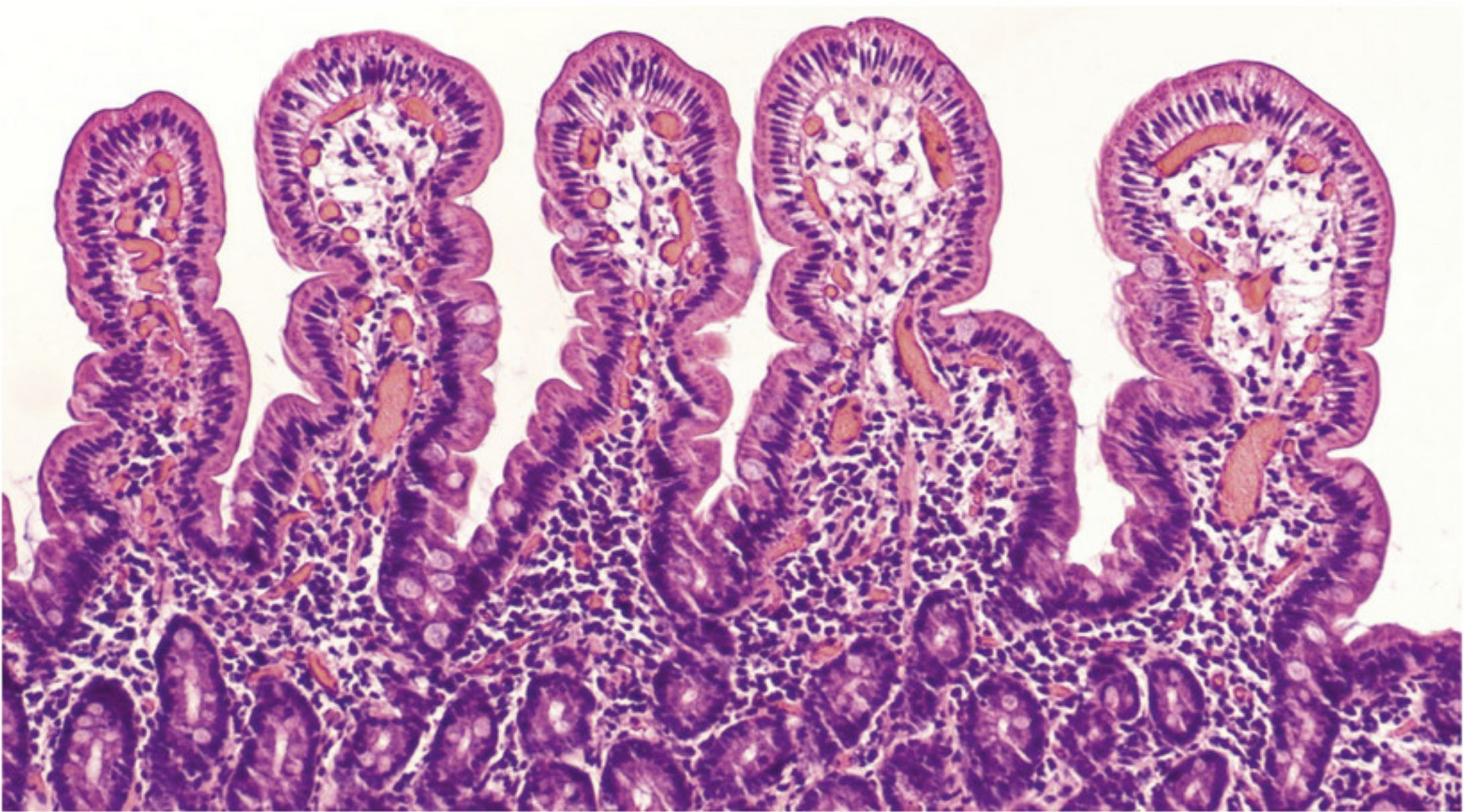
Table 2 The effect of bile on the fat concentration in milk.

Glass beaker	Solution
1	100 mL milk 5 mL pancreatic juice 5 mL water
2	100 mL milk 5 mL bile 5 mL water
3	100 mL milk 5 mL pancreatic juice 5 mL bile

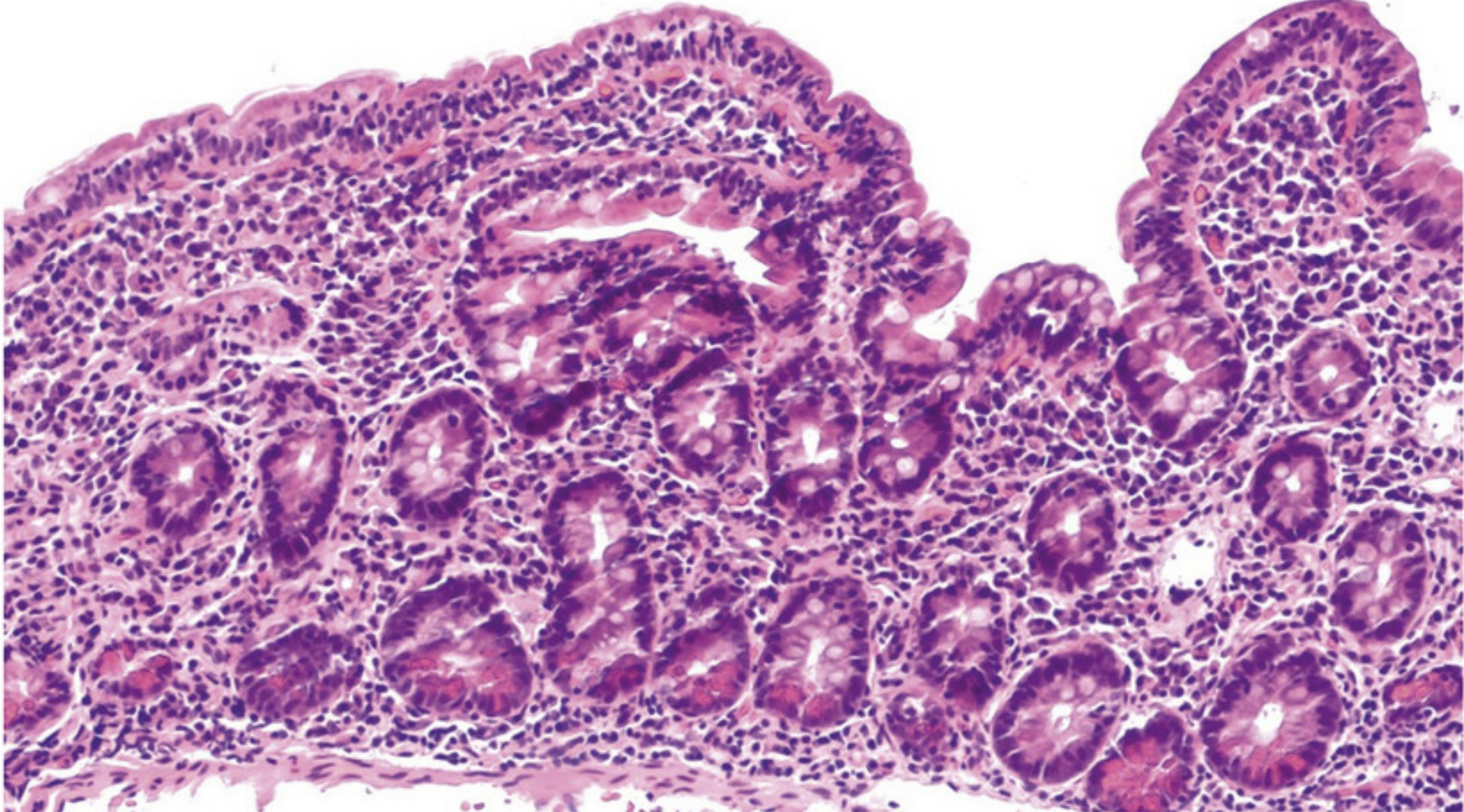
7

Someone who suffers from coeliac disease cannot tolerate gluten. Gluten is a protein that is found in grains. In someone with coeliac disease, the intestinal wall of the small intestine gets damaged by gluten (see figure 9).
Explain why this can also make someone with coeliac disease lose a lot of weight.

fig. 9 Intestinal villi from the wall of the small intestine (microscope photos).



1 of a healthy person



2 of a person with coeliac disease

8

Figure 10 shows a magnified drawing of three intestinal villi in a section of the small intestine. A few parts of the figure are numbered. The direction of the blood flow is indicated by arrows.

Danny has eaten two cheese sandwiches. Carbohydrates and proteins are digested at location 1.

a Where are the enzymes produced for digesting carbohydrates and proteins?

b Fats are also digested at location 1.

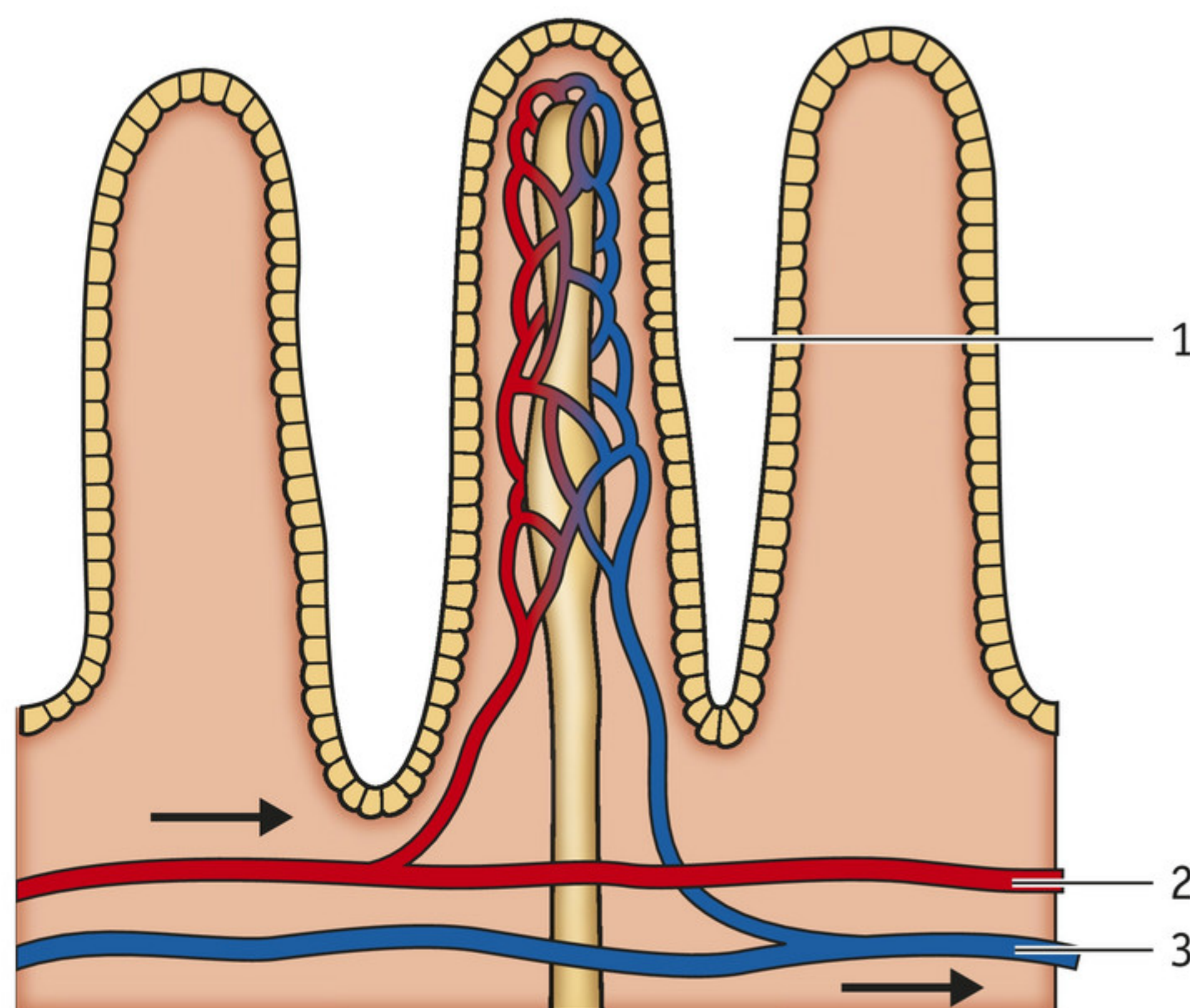
Where are the enzymes produced for the digestion of fats?

c Can digestive products be found at:

- position 1? *yes / no*
- position 2? *yes / no*
- position 3? *yes / no*

d What happens to the digestion products that were absorbed into the blood from the small intestine?

fig. 10



+ 9

Lucy has an ear infection caused by bacteria. Her GP prescribes a course of antibiotics. The antibiotic pills cause a particular substance to be taken up less in Lucy's blood. Which substance is that? Explain your answer.

HOW IT FITS TOGETHER science

INTESTINAL BACTERIA DETERMINE HOW MUCH FAT YOU STORE

Trillions of bacteria live in your intestinal tract. All the bacteria in the intestinal tract together are known as the microbiome (previously also called the intestinal flora). The microbiome appears to be different in overweight people than in thinner people. Exactly how it works is not known, but it seems that eating a lot of dietary fibre helps gives you the microbiome of a thin person, making you lose weight. If you eat fatty foods with little fibre, you are most likely to store fat as food reserves.

The microbiologist Willem de Vos and physician Max Nieuwdorp investigated this in mice. Mice with a lot of dietary fibre in their diet were thinner. The thin mice also had a different microbiome to mice that ate little dietary fibre. In the thin mice, the food pulp moved through the intestinal tract more quickly. Nutrients were broken down less well by the digestive juices and provided less energy. The microbiomes of the thinner mice also meant that more fats were burned in the body cells.

fig. 11 A high-fibre breakfast.



10

Read the text 'Intestinal bacteria determine how much fat you store'.

The digestive system of mice is similar to that of humans. Results from studies in mice may therefore possibly also apply to humans.

- a** Explain how dietary fibre can play a role in making people slimmer.
- b** Prebiotics are dietary fibres that stimulate the growth of good intestinal bacteria. You can buy prebiotics in jars, but some foods also contain a lot of prebiotics. There are also drinks with probiotics. These drinks contain bacteria that are supposed to be good for the intestinal function.
Use your knowledge of the digestive system to explain why probiotics probably work less well than prebiotics.
- c** The microbiome of the thin mice also meant that more fat was burned in the body cells.
Explain why this made the mice stay thinner.
- d** Where in the digestive system does dietary fibre have the most influence on the combustion of fat?

 Go to the *Flash cards* and the *Test yourself* section.

4 Healthy food

LEARNING OBJECTIVES

- 2.4.8

You can use the Wheel of Five to give advice about a healthy diet.
- 2.4.9

You know what a healthy weight is and what choices can help maintain it.
- 2.4.10

You can name the possible causes and consequences of eating disorders and give a few examples.
- Learning how to do research 2

► Practical activities 7 and 8

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES		
	2.4.8	2.4.9	2.4.10
Remembering	1a		
Understanding	1abc, 4	2, 4, 8b	3, 4
Using	5, 6, 7	6, 7, 9ab, 10bc	
Analysing	8a, 10a	8ac, 9c, 10ad	

Good nutrition is needed if you are to stay healthy. Your body uses food as building materials, fuel and spare reserves, as well as for protection. All these functions added together determine how much nutrition you need.

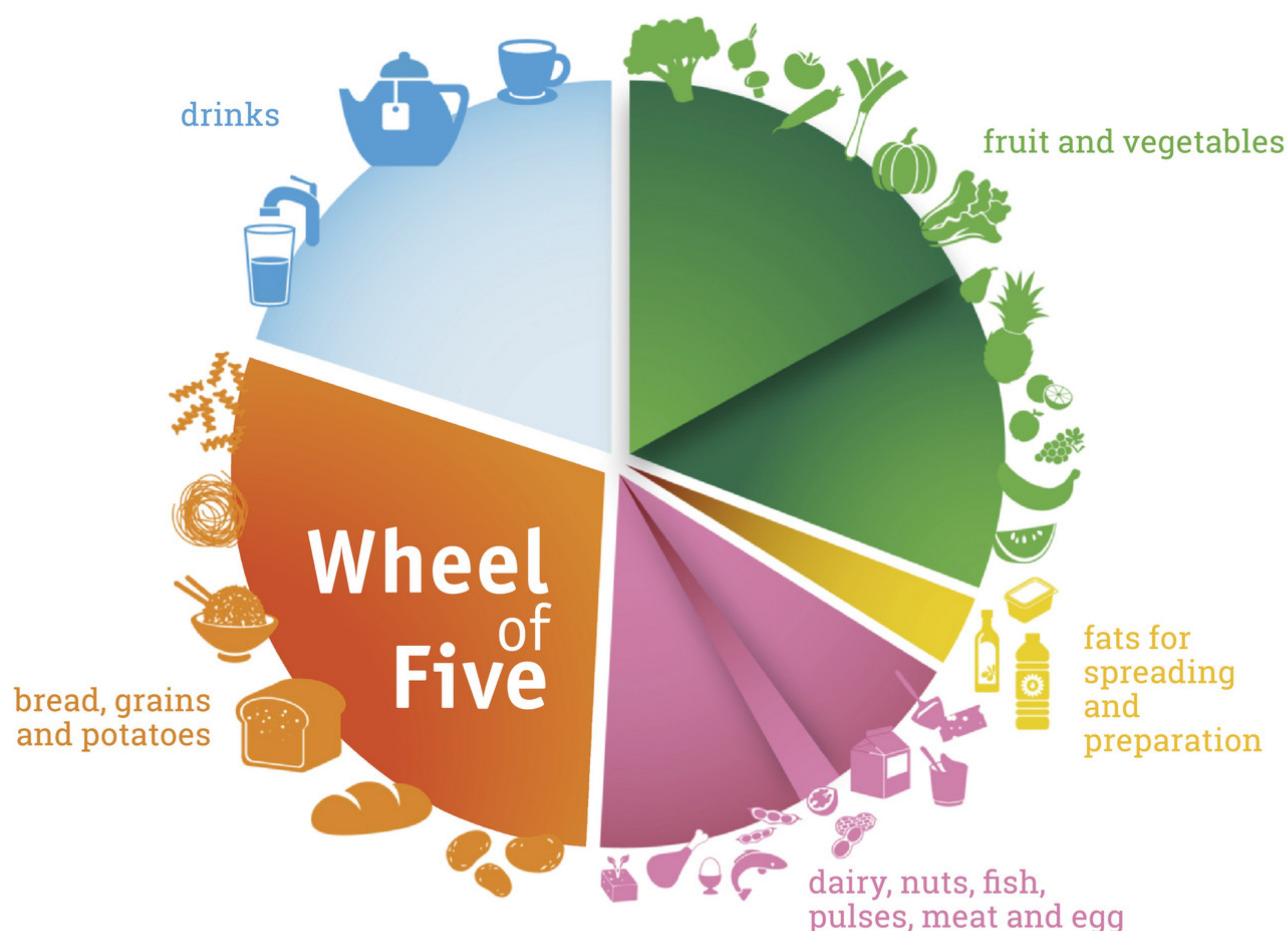
THE WHEEL OF FIVE

The Netherlands Nutrition Centre gives information about good and healthy food. The Wheel of Five is a useful tool: five pie slices with the types of foods that you need every day (see figure 1). Each section stands for a product group. Each product group has benefits for your health and provides an important nutrient:

- green: primarily vitamins
- yellow: mainly fats
- pink: largely proteins
- orange: mostly carbohydrates
- blue: principally water

The products shown in the sections also provide other nutrients, though. Fats contain vitamins that are soluble in fat but not in water. The products from the pink section contain B vitamins and other fat-soluble vitamins; cereals also contain B vitamins and protein, and so forth. Dietary fibre is mainly found in the green and orange sections. Minerals can be found in all sections.

If you eat products from each section every day, your body will get all the nutrients it needs. You should eat more food from the larger sections than from the small ones (see figure 2). The large sections only contain foods derived from plants. The pink section contains both animal products and plant products. The yellow section mostly contains vegetable oils and fats.

fig. 1 The Wheel of Five.**fig. 2**

Five recommendations for healthy eating

1 Plenty of vegetables and fruit (green)

250 grams of vegetables and two portions of fruit every day is healthy: if you eat a lot of vegetables and fruit, it reduces the risk of cardiovascular diseases, colon cancer and type 2 diabetes.

2 Soft and liquid fats (yellow)

Unsaturated fats are good for your blood vessels – oil and low-fat margarine, for instance.

3 More vegetable products, less meat (pink)

That is good for you and for the environment. You can vary with fish, pulses, meat, nuts and eggs. You can also eat no meat. And don't consume more dairy products than you need.

4 Wholemeal in particular (orange)

Wholemeal bread, wholemeal pasta, brown rice, wholemeal couscous: if you eat enough of these, it reduces the risk of cardiovascular disease, colon cancer and type 2 diabetes.

5 Sugar-free thirst quenchers (blue)

Your body needs liquid every day, but not extra sugar. That is why the Wheel of Five lists drinks without calories: water, coffee and tea.

Not too much and not too often

The Wheel of Five does not contain products with too much salt, sugar or saturated fats, or with little fibre. It's fine to have some of those every now and then, but not too much and not too often.

ENERGY

A large proportion of your food is used as fuel. That part of your food provides the energy that your body needs. The amount of energy in food is stated in **kilojoules** (symbol kJ). A Mars bar contains about 1000 kJ energy; an apple has about 300 kJ. Another unit for the energy in food is the **kilocalorie** (kcal). Someone who talks about the ‘calories’ in food is actually talking about kilocalories. You can convert between the units:

1 kcal = 4.2 kJ

How much energy is needed every day varies from person to person. It depends on things such as your sex, body size, physical activity and age. On average, boys (men) need more energy than girls (women). While you are growing, your energy requirements are greater. Energy requirements are less in older people too.

Table 1 shows the average energy requirement for various phases of life and different lifestyles. Table 2 shows roughly how much energy you need for various activities. You also need energy even when you are resting.

Table 1 Average energy requirements.

	kJ per day
Boys aged 14 to 18	
with a relatively inactive lifestyle	11,340
with an active lifestyle	13,020
Girls aged 14 to 18	
with a relatively inactive lifestyle	8,820
with an active lifestyle	10,080
Men aged 31–50	
light physical work	10,920
heavy physical work	12,600
Women aged 31–50	
light physical work	7,980
heavy physical work	9,660

Tabel 2 Energy requirements for various activities.

	kJ per minute
Sleeping	5
Walking	18
Jogging	30
Climbing stairs	46
Rowing race	54

WEIGHT

What you eat and how much you eat affects your weight. In general, your weight will stay the same if the amount of energy you consume is the same as the amount of energy you use. If you eat more than you need, some of the nutrients are stored as a food reserve. That mainly happens in the form of fat. As a result, you get heavier. If you eat less than you need, your body starts using its reserves as an energy source. As a result, you lose weight.

But your weight is also related to your hereditary characteristics. Some people are more heavily built than others, have a different metabolism, or a thicker or thinner layer of subcutaneous fat (see figure 3).

fig. 3 Everyone is built differently.



In **overweight** and **obesity** (being severely overweight), too much fat is stored in the body. Overweight people have more health risks than people with a healthy weight. They have a higher risk of developing cardiovascular diseases and type 2 diabetes. Being overweight is also bad for your joints because they are too heavily loaded. When your bodyweight is too low, you are said to be **underweight**. Being underweight is not healthy either, because you might have nutrient deficiencies. The body then first uses the food reserves from fat and muscle tissue. When those run out, the muscles are broken down. Underweight people become ill more easily and can feel lethargic and tired. If you are underweight for a long time, there is an increased risk of bone fractures. Being underweight can be a consequence of undernourishment. In **malnutrition**, someone gets too little energy or not enough nutrients. This is usually due to getting insufficient food or food with too few nutrients (generally protein). Eating too much junk food can cause nutrient deficiencies too. Junk food such as hamburgers, crisps and pizza may have very little nutrients.

BMI

You can see if your weight is healthy by working out your **body mass index (BMI)**. You can do that by dividing your bodyweight (in kilograms) by the square of your height (in metres):

$$\text{BMI} = \frac{\text{weight}}{\text{height} \times \text{height}}$$

Example: Jack weighs 70 kg and is 1.73 m tall. His BMI is $\frac{70}{1.73 \times 1.73} = 23.4$.

Adults usually have a healthy weight if their BMI is between 20 and 25. This is harder to say for young people because they are still growing. Table 3 shows the average values for a healthy weight in young people aged 12 to 14. In addition to BMI, the abdominal circumference is also important. Having fat in and around the abdomen is bad for your health.

Table 3 Healthy weight (BMI).

Age	BMI	
	Girls	Boys
12	15.6–21.7	15.8–21.9
13	16.3–22.6	16.4–22.6
14	16.9–23.3	17.0–23.3

GAINING AND LOSING WEIGHT

If you are overweight or underweight, you can try to get your weight to a healthy value. Some people who are overweight try to lose weight by eating less than the recommended amounts or skipping a meal. That is not a very good way. This can result in bouts of overeating. And if you want to put on weight, it is not a good idea to eat too much or unhealthy food. Table 4 shows healthy ways of working on your weight.

Table 4 Healthy ways of working on your weight.

Losing weight*	Gaining weight
1 Eat normal quantities and get more exercise.	1 Eat at fixed times, at least three meals per day.
2 If you eat snacks, choose something with not much fat or carbohydrates.	2 Try to increase the amount you eat step by step. Take your time and chew well.
3 Eat only the recommended quantities. That often means more bread, more fruit, more vegetables, less meat and less cheese.	3 Get enough exercise and eat products with a lot of protein. This helps to put on muscle.
4 Always eat the smallest quantities of the recommended amounts.	4 Eat some extra fat, such as fatter meat, full milk and 48+ cheese. Nuts, avocado and oily fish are also suitable.
5 Don't eat any snacks at all in between meals. Do drink enough water, or tea with no sugar.	5 Eat enough dietary fibre. This is needed for proper intestinal function.

* Method 1 is the least strict and method 5 is the strictest.

EATING DISORDERS

People with an **eating disorder** spend all day thinking about food and how it affects their body. To them, eating is a source of anxiety and stress. They have a negative image of themselves, their bodyweight and their appearance. Eating disorders include anorexia nervosa, bulimia nervosa and binge eating disorder.

Someone with **anorexia nervosa** is not overweight but they feel that they are. Symptoms of this eating disorder are losing extreme amounts of weight and being very worried about putting on weight. Someone suffering from anorexia does get hungry but they refuse to eat (or not enough). This results in malnutrition and being underweight. Anorexia can lead to diseases, problems with the stomach and teeth, and hair loss. About 6% of anorexia patients die as a result of the disease.

Someone with **bulimia nervosa** is also worried about being too fat and they also don't eat enough, but they then do have regular eating binges. They may then make themselves vomit to get rid of the food, or use large amounts of laxatives. This process of fasting, vomiting and using laxatives causes malnutrition. The walls of the windpipe can also get irreparably damaged. About 4% of bulimia patients die as a result of the disease.

Someone with **binge eating disorder** has eating binges, but they do not vomit it back up or use laxatives. That is why this eating disorder can lead to severe overweight (obesity).

The cause of an eating disorder is often psychological. Someone with an eating disorder generally has a negative self-image. Some causes of eating disorders are:

- influences from your culture or the media (see figure 4)
- bad events in your life
- wanting to feel in control
- fear of failure or perfectionism
- being dissatisfied with yourself or your outward appearance

You cannot solve an eating disorder on your own because it is about more than just food. The longer someone suffers from an eating disorder, the more difficult it is to treat. That is why it is important that someone with an eating disorder gets help as soon as possible. A confidential talk with their family doctor is a good start.

fig. 4 Influence of beauty ideals in the media.



KNOWLEDGE

1

In the Wheel of Five, each section stands for a product group.

- a** Why should you eat things from each of the five sections of the Wheel of Five every day?
- b** Which is the healthiest choice?
- *wholemeal spaghetti / white spaghetti*
 - *a lot of animal-based food / a lot of plant-based food*
 - *oil / solid fat*
 - *soft drink with sugar / water*
 - *eggs / meat*
 - *brown bread / wholemeal bread*
 - *a lot of vegetables and fruit / a lot of dairy products*
- c** Which substances belong to which section of the Wheel of Five?
- | | | |
|--|-----------------------|--|
| A section: bread and potatoes (or rice, macaroni, spaghetti, pulses, couscous) | ☐ | ☐ 1 protein, vitamins and minerals |
| B section: drinks | ☐ | ☐ 2 fats and vitamins |
| C section: fruit and vegetables | ☐ | ☐ 3 vitamin C and dietary fibre |
| D section: margarine, low-fat margarine or oils | ☐ | ☐ 4 water |
| E section: milk, cheese (or other dairy produce) and meat, meat products, chicken, fish, egg or meat substitutes | ☐ | ☐ 5 starch, proteins, vitamins, minerals and dietary fibre |
- d** Which recommendations for healthy eating are about dietary fibre?
- ☐ A Eat plenty of vegetables and fruit.
 - ☐ B Eat products with unsaturated fat.
 - ☐ C Eat more plant-based and less meat-based food.
 - ☐ D Eat mainly wholemeal products.
 - ☐ E Drink thirst quenchers without sugar.
 - ☐ F Not too much and not too often.

2

Sara is 1.65 m tall and weighs 50 kg. She is 13 years old.

- a** What is Sara's BMI?
- b** Use table 3.
Is Sara's weight healthy? *yes / no*
- c** Sara's father weighs 93 kg and is 1.72m tall.
What is the BMI of Sara's father?
- d** Which recommendation is right, given the BMI of Sara's father?

3

Edith has seen a lot of advertisements with the bodies of top models, which has made her feel too fat. Because of this, she is eating too little to get enough nutrients. Edith is underweight.

- a** What two causes of eating disorders can you deduce from the text?
- b** What is the difference between bulimia nervosa and binge eating disorder?
- c** Explain why binge eating disorder is harmful.
- d** What is the best thing someone with an eating disorder (or their family or friends) can do?

4

Summary

Make a summary of the basics, for instance in a word web.



INSIGHT

5

In this exercise, you are going to work on the list of products you made in Exercise 8 of Basics 1.

You are going to investigate the percentage of the average daily energy requirement that you get from snacks. Snacks are everything you eat and/or drink between main meals.

- a Take out your completed list.
- Make a note of the snacks that you ate or drank that day in the first column of the table, along with the quantities. Examples: 2 rich biscuits.
 - Enter the amount of energy the snack provides in the second column. Use table 5 for this. Examples: 400 kJ.
 - Add up the total number of kJ of energy that you get from these snacks and write down that number.

Snack	energy in kJ
Total	

- b Compare the total amount of energy from your snacks with the average daily energy requirement.
- What percentage of the average daily energy requirement do you get from snacks?
- c Healthy snacks are low in carbohydrates and fats.
- Do your snacks meet this recommendation?

Table 5 Kilojoules per snack.

Snack	kJ	Snack	kJ
1 glass of water or mineral water	0	1 Choco Prince biscuit	500
1 cup of tea/coffee	0	1 sweet biscuit	550
1 dash of coffee creamer	45	1 packet of crisps	700
1 lump/teaspoonful of sugar	100	1 ice cream	700
1 plain biscuit	100	1 handful of peanuts	700
1 rich biscuit	200	1 portion of mayonnaise	800
1 beaker of low-fat yoghurt	200	1 almond pastry	900
1 apple/pear/orange	200	1 meat croquette/deep-fried sausage	900
1 slice of cake	225	1 Mars/Bounty etc.	1000
1 glass of soft drink/fruit juice	240	1 bar of chocolate	1000
1 banana	350	1 cream cake	1100
1 savoury biscuit with a sweet spread	400	1 sausage roll	1300
1 cracker with soft cheese	400	1 custard slice	1300
1 handful of liquorice sweets	400	½ smoked sausage	1300
1 slice of sticky cake/baklava	400	1 portion of French fries	1900

6

In this exercise, you are going to work on the list of products you made in the previous exercise and in Exercise 8 of Basics 1.

You are going to investigate whether your diet is balanced.

The 'Food Log' is a food diary that lets you fill in what you eat and drink each day.

You can find the program and the 'Food Log' app via the Netherlands Nutrition Centre ('Voedingscentrum') website (search for 'eetmeter').

- Start the program. When you use it for the first time, you will need to register.
- Log in and select 'Mijn dagboek' (My diary) from 'Mijn Eetmeter' (My food log) in the main menu.
- Enter your list of products.
- Go to 'Mijn dagboek' (My diary) and select 'Adviezen' (Advice).
- Print the recommendation.
- Compare the recommendation you were given with what a classmate got.

Would you want to change anything in your lifestyle after this exercise? Explain your answer.

7

Food is available almost everywhere in the Netherlands, for instance at school, in the shops and at home. That is why you come into contact with food and drinks all day. That food is often not included in the Wheel of Five. It can easily tempt you to eat unhealthily.

a For one day, take pictures of all the food temptations you come across. Think of:

- at home: a biscuit tin on the table
- at school: the snack machine, the canteen
- on your bicycle: a snack bar on the way

b Have a look at your photos.

Where do you encounter the most food temptations?

c Some food temptations are hard to avoid. But there are also temptations you can do something about. For example, you can suggest to your parents that the biscuit tin could be put in a cupboard (or just do it yourself).

What food temptations can you do something about yourself? For each temptation, write what you could do about it.

8

Mark eats a cheese sandwich. Eric eats a peanut butter sandwich. Mark says that a sandwich with cheese is healthier because even full-fat cheese has less fat than peanut butter. Despite that, peanut butter is on the Wheel of Five but full-fat cheese is not.

a Use table 6 to give three reasons why peanut butter is healthier than cheese.

b Eric's sandwich has 15 g peanut butter.

How much energy does 15 g peanut butter provide in kcal? kcal

c Adam wants to lose weight and eat no fat at all.

Explain why it is a bad idea to stop eating fats entirely.

Table 6 Nutritional value per 100 grams.

	Full-fat cheese	Peanut butter
Energy (kJ)	1604	2625
Fat	32	52
• of which unsaturated	20	7
Carbohydrates	0	12
Dietary fibre	0	6
Protein	25	26
Salt	1.8	0.5

9

- a** Suppose there are two girls of the same weight and age; one is a film enthusiast and the other a passionate street dancer.
Which girl is likely to need more energy? Explain your answer.
- b** Anna suffers from anaemia. Khalid has had a heart attack. Matt is often ill.
- Which of them has a problem that could be caused by being overweight?
Anna / Khalid / Matt
 - Which of them has a problem that could be caused by being underweight?
Anna / Khalid / Matt
- c** Toby plays sports three times a week outside school hours and cycles 16 km to school every day. Sam cycles 2 km to school every day and rarely plays sport outside school hours. Assume that both boys are 15 years old, the same height and the same weight, and that they get the same amount of energy from their food every day.
100 g peanuts provides 623 kcal. A packet of peanuts weighs 150 g. How many packets of peanuts can Toby eat per week compared to Sam? Include a calculation in your answer.

HOW IT FITS TOGETHER biology in professional life

DIETICIAN

Karen is a dietitian at a health centre, where she works with patients who need advice because of their illnesses: “These are people with diabetes, for instance, or who are overweight or underweight. I also give advice to healthy people who want to take a fresh look at their diet, for example a woman who is pregnant or someone who wants to lose weight sensibly.

In the first consultation, we discuss why people have come to me. We go through their eating habits and then look to see exactly what the problem is. Then we look to see what can be done about it and draw up a treatment plan. In the follow-up consultations we discuss how things are going and we think of solutions for the issues that are encountered.”

fig. 5 Karen, a dietitian, at work.



10

- Read the text ‘Dietician’.
- Suzanne goes to Karen. Karen does not just ask questions about her food patterns and preferences for certain foods. She will have to ask Suzanne at least two more questions.
- a Explain what those two questions are and why she asks them.
 - b After asking a few questions, Suzanne turns out to be both overweight and malnourished.
Suzanne asks, “If I am overweight, how can I be malnourished too?”
Answer Suzanne’s question.
 - c Suzanne likes to eat cheeseburgers. She likes to drink water with that. The composition of cheeseburgers is given in table 7.
Recommendations from the Wheel of Five:
 - 1 plenty of vegetables and fruit
 - 2 soft and liquid fats
 - 3 more plants, less meat
 - 4 mainly wholemeal
 - 5 Thirst quenchers without sugarWhich recommendation does Suzanne’s menu comply with?
recommendation 1 / 2 / 3 / 4 / 5
 - d Karen measures round Suzanne’s body at the height of the belly button.
Explain why she does that.

Table 7 Suzanne’s menu.

Nutritional value of one cheeseburger	
Energy (kcal)	405
Fat (g)	13
Saturated fat (g)	13
Carbohydrates (g)	30
Fibre (g)	0.1
Protein (g)	18
Salt (g)	3

 Go to the *Flash cards* and the *Test yourself* section.

5 Food spoilage

LEARNING OBJECTIVE

2.5.11 You can describe ways to prevent food spoilage.

TAXONOMY	LEARNING OBJECTIVE AND EXERCISES
	2.5.11
Remembering	1ac
Understanding	1b, 2, 3, 4
Using	5, 6ab, 7, 8ab, 10a
Analysing	6cd, 8cd, 9, 10bc

In nature, bacteria and fungi clear up the dead remains of organisms. Your food also consists of (dead) residues of organisms, such as meat, vegetables and fruit. Bacteria and fungi love that.

FOOD POISONING

Bacteria and moulds (which are fungi) can live on vegetables, meat, fruit and other food. This is why food can go bad (see figure 1). You cannot eat spoiled food because it would make you ill. You are then suffering from **food poisoning**. This is an immune reaction caused by eating food that has been contaminated with toxins. Those toxins are produced by bacteria or moulds. You can usually see or smell that food has spoiled, but not always.

Salmonella is a bacterium that occurs widely in animals, particularly poultry and pigs. **Salmonella bacteria** can occur in raw animal products, such as meat, fish and eggs, and on raw vegetables and fruit. The bacteria can multiply very quickly, particularly at temperatures of between 20 and 30 °C. It is dangerous to eat food that has been contaminated with salmonella bacteria. An infection can cause symptoms such as diarrhoea, abdominal pain and fever. The bacteria affect the small intestine and cause inflammation there. The symptoms usually appear within 12 to 36 hours and last two to three days.

fig. 1 Spoiled ham.



PRESERVING FOOD

Foods can be treated so that they spoil less quickly. This is called **preserving**. Preserving food makes the conditions unfavourable for bacteria and fungi. Many bacteria and fungi then die. Most bacteria and fungi cannot survive at low or high temperatures. Methods of preserving can include freezing, pasteurization, sterilization and drying. Preservatives may also be added.

FREEZING

Cooling food to temperatures of -20°C or less lets you keep food in a deep freeze for several weeks or even months. This temperature is too low for bacteria and moulds to be able to reproduce. But once the food is defrosted, the bacteria and fungi can reproduce quickly again. Food from the freezer should therefore be prepared quickly once it has been thawed. You should not freeze it again.

PASTEURIZATION

Heating milk briefly to 72°C kills many bacteria and fungi. This is called **pasteurization**. The milk can be kept for longer but not all the bacteria and moulds have been killed. That is why you keep pasteurized milk in the refrigerator. This slows the growth of bacteria and moulds.

STERILIZATION

Sterilization does kill all the bacteria and moulds. This is because the temperature is higher in sterilization than in pasteurization. Milk, for example, is heated to $130\text{--}140^{\circ}\text{C}$. After this, the milk is packaged and heated again. These steps have to be done in quick succession, because new bacteria and moulds could get into the milk if it was allowed to cool. All kinds of foods, such as vegetables, are sterilized and then canned (airtight packaging).

fig. 2 Freezing.



fig. 3 Pasteurization.



fig. 4 Sterilization.



VACUUM PACKING

Food can also be vacuum packed. This involves sucking all the air out of the packaging. Bacteria and moulds cannot reproduce because there is no oxygen. One example is ground coffee, which is first roasted and then vacuum packed.

INERT ATMOSPHERES

A lot of meat and vegetables are packed in inert atmospheres. There is no air in the plastic packaging, but a mixture of gases such as carbon dioxide, oxygen and nitrogen. This lets meat and vegetables keep longer, and meat retains its colour longer too.

fig. 5 Vacuum-packed food.



fig. 6 Food packed under an inert atmosphere.



DRYING

Removing all the water from food prevents bacteria and fungi from reproducing. Examples of dried products are milk powder, raisins and packet soups.

ADDING PRESERVATIVES

Adding **preservatives** such as sugar, salt, acids (such as vinegar) or nitrogen make the conditions unfavourable for bacteria and fungi. Examples are the sugar in jam and the salt in fresh herrings and olives.

fig. 7 Drying.



fig. 8 Preservatives.



IRRADIATION

Foods are sometimes irradiated with gamma rays from a radioactive source. This makes bacteria and fungi less able to reproduce, or kills them. Irradiation is only permitted where there is a high risk of bacteria and fungi that could make people ill, such as in chicken for instance.

ADDITIVES

A preservative is an example of an additive. **Additives** are substances that are added to foodstuffs so that they will keep for longer or are more attractive in some way. Sugar, vinegar and salt are natural additives.

Colourings are often added to food to make it look more attractive. **Aromas** and **flavourings** are sometimes added too. Colours, aromas and flavourings can be natural additives, such as the pigment from beetroots. That substance is used to colour food red. They can also be artificial. Artificial additives are made in factories. They do not occur in nature.

If no artificial additives are added to food, it will often clearly say so on the packaging (see figure 9).

fig. 9 Food without artificial additives.



KNOWLEDGE

1

- a What is food poisoning?
- b Salmonella bacteria reproduce fastest at temperatures of 15 °C / 25 °C / 35 °C.
- c What is the name for treating food so that it does not spoil?

2

Which method of preserving belongs with each description?

- | | | |
|---|-----------------------|---|
| A All the air is sucked out of the packaging. | ☐ | ☐ 1 additives |
| B Pickling gherkins (putting them in an acidic solution). | ☐ | ☐ 2 drying |
| C Taking the temperature down to –20 °C or lower. | ☐ | ☐ 3 freezing |
| D Removing water from the food. | ☐ | ☐ 4 adding artificial preservatives |
| E Adding flavourings. | ☐ | ☐ 5 adding natural preservatives |
| F Mixing sulphite into drinks. | ☐ | ☐ 6 pasteurization |
| G Heating to a temperature of 72 °C. | ☐ | ☐ 7 sterilization |
| H Heating to a temperature of 130–140 °C. | ☐ | ☐ 8 Vacuum packing |

3

Preservation methods can involve:

- 1 adding preservatives
- 2 making the temperature unfavourable
- 3 removing water
- 4 removing oxygen

What methods of preserving are being used here? Write down the right number for each method.

- | | |
|--|------------------------|
| • injecting a drink with sulphite | • freezing |
| • drying | • pasteurization |
| • inert atmospheres | • sterilization |
| • pickling (putting in an acidic liquid) | • vacuum packing |
| • canning and | |

4



Summary

- Explain what food poisoning is.
- Explain what preserving means.
- Complete the table.

.....

.....

.....

.....

Principle	Method of preservation	Working method and why it works
Radioactive radiation		
Adding preservatives		
Making the temperature unfavourable		
Removing water		
Removing the oxygen		

INSIGHT

5

Figure 10 shows four methods of preservation.

a Which photo belongs with which description?

- | | | |
|--|-----------------------|---------------------------------|
| A Microorganisms cannot reproduce at -20°C . | ☐ | ☐ 1 photo 1 |
| B Heating the food to 72°C kills most microorganisms. | ☐ | ☐ 2 photo 2 |
| C Microorganisms are unable to grow and reproduce if there is no moisture. | ☐ | ☐ 3 photo 3 |
| D Microorganisms cannot reproduce without oxygen. | ☐ | ☐ 4 photo 4 |

b Write down the name of the preservation method under each photo.

fig. 10 Preserving methods.



6



Read the text 'Sauerkraut' in figure 11.

During the production of sauerkraut, the amount of lactic acid in the cabbage changes.

- a** Draw this change in the diagram in figure 12.
- b** Sauerkraut is often packaged in plastic.
Which method of preservation is this?
- c** Are any additives added to sauerkraut to make it last longer? Explain your answer.
- d** Organisms can defend themselves against their surroundings in various ways.
How do lactic acid bacteria defend themselves?

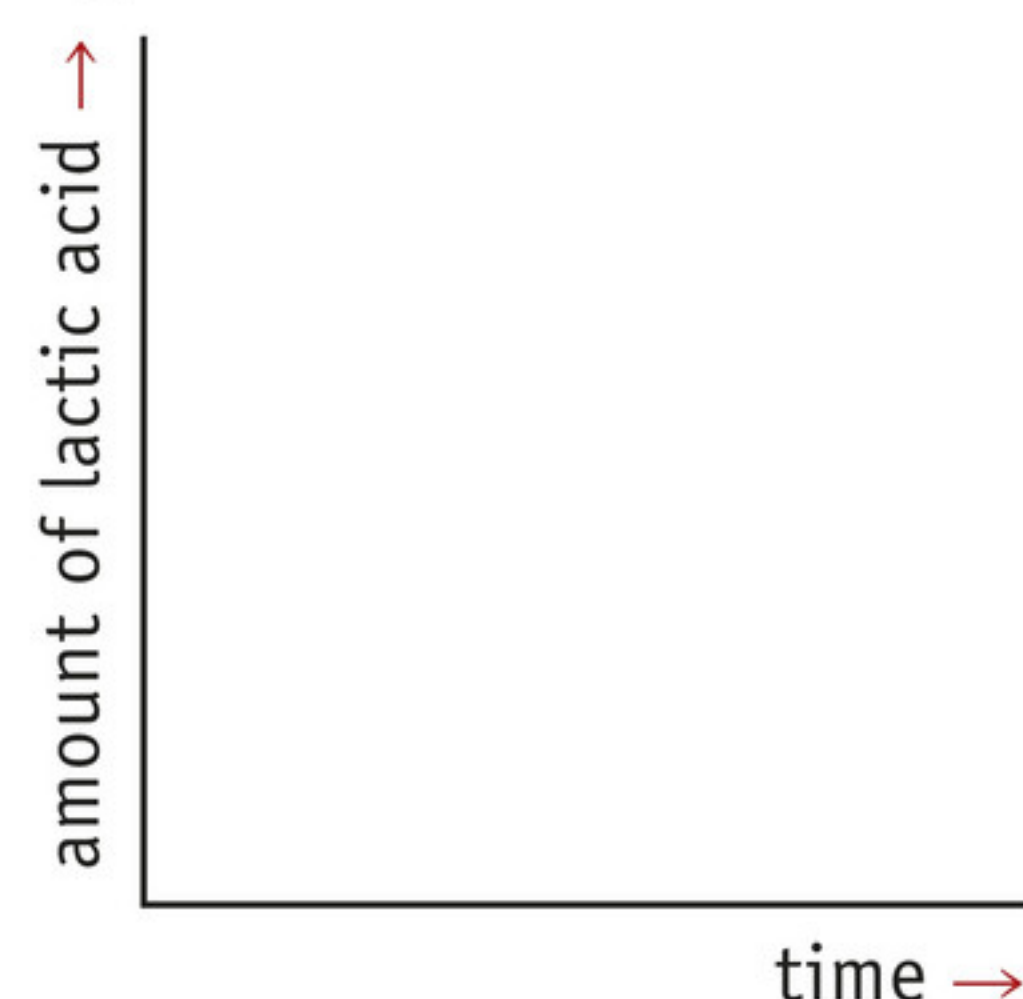
fig. 11

Sauerkraut

To make sauerkraut, clean and finely chopped raw white cabbage leaves are sprinkled with salt. The cabbage is then covered and compressed using something heavy. The sauerkraut is ready after three to eight weeks. During that time, lactic acid bacteria have partially converted certain substances in the cabbage leaves. Among other things, this produces lactic acid. Lactic acid is what gives the sauerkraut its clean, sharp taste. In this case, microorganisms do not spoil the food.



fig. 12



7

Stockfish is cod that has been hung for about three months (see figure 13). The fish is usually hung up in open plains or on the coast.

- a What preservation method is being used in stockfish?
.....
- b Stockfish is made in the winter in the north of Norway. Explain why it is done then and there.
- c Why is the fish is hung up in open plains or on the coast?

fig. 13 Stockfish.



8

- a Figure 14.1 shows blue cheese. Blue cheeses are types of foods that have been affected by moulds and/or bacteria. Explain why blue cheese looks like spoiled food.
- b Is blue cheese also spoiled food? Explain your answer.
- c Figure 14.2 shows you a factory where they make cheese using special bacteria and moulds. Why do the staff wear gloves, a plastic cap and a facemask?
- d Figure 14.3 shows a Gouda cheese that is maturing. Which preservation method can you see in the photo? Explain your answer.

fig. 14



1 blue cheeses



2 staff in a cheese factory



3 Gouda cheese

+ 9

What is the similarity between the preservation method in a carton of long-life milk and in canned vegetables?

HOW IT FITS TOGETHER the world we live in

WHY ARE THERE COLOURINGS IN MY SALMON?

Would we buy salmon in the supermarket if it wasn't salmon pink but was instead as white as cod? Producers of farmed salmon already know the answer: appearance matters and colour is important to the consumer. That is why farmed salmon are given colourings in their food that turns the salmon flesh pink.

It sounds unnatural, but it is not so bad.

The colouring that the farmed salmon are given in the tank is the same as the one

that turns the wild members of its species salmon pink. This substance, astaxanthin, is produced by algae when they are stressed. Those algae are eaten by shrimps, colouring them pink. When the wild salmon eat the shrimps, the astaxanthin ends up in the salmon's fat and muscle tissues. Why are flamingos pink? Yes – exactly the same story.

Source: *De Volkskrant* newspaper, Tonie Mudde, 25 July 2015.

fig. 15



10

Read the text 'Why are there colourings in my salmon?'.

a Astaxanthin is added to the food of farmed salmon.

Astaxanthin is *an additive* / *an artificial preservative* / *a natural preservative*.

b Farmed salmon is made ready for consumption in many different ways. One way is hot smoking it. The salmon is hung over a smouldering fire of wood chips or sawdust to flavour it. The temperature in the smokehouse is about 75 °C, which makes the fish keep for longer.

Does smoking make the salmon keep longer and/or more appetising? Explain your answer.

c Salmon is easy to cook on the barbecue. But salmonella contamination occurs regularly when people barbecue salmon. Explain how.

 Go to the *Flash cards* and the *Test yourself* section.

6 Nutrition and digestion in mammals

LEARNING OBJECTIVE

2.6.12 You can state the relationships in mammals between the choice of diet, the length of the intestinal tract and features of their teeth. ► Practical activity 9

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES	
	2.6.12	2.1.2*
Remembering	1, 2, 3	
Understanding	4	
Using	5, 8a	
Analysing	6, 7, 8b, 9, 10	10a

* You can find this learning objective in another Basics section.

Humans are omnivores: they eat plants and animals. Many other mammals eat only plants or only animals. The teeth of mammals are adapted to their diets.

PLANTS AND/OR ANIMALS

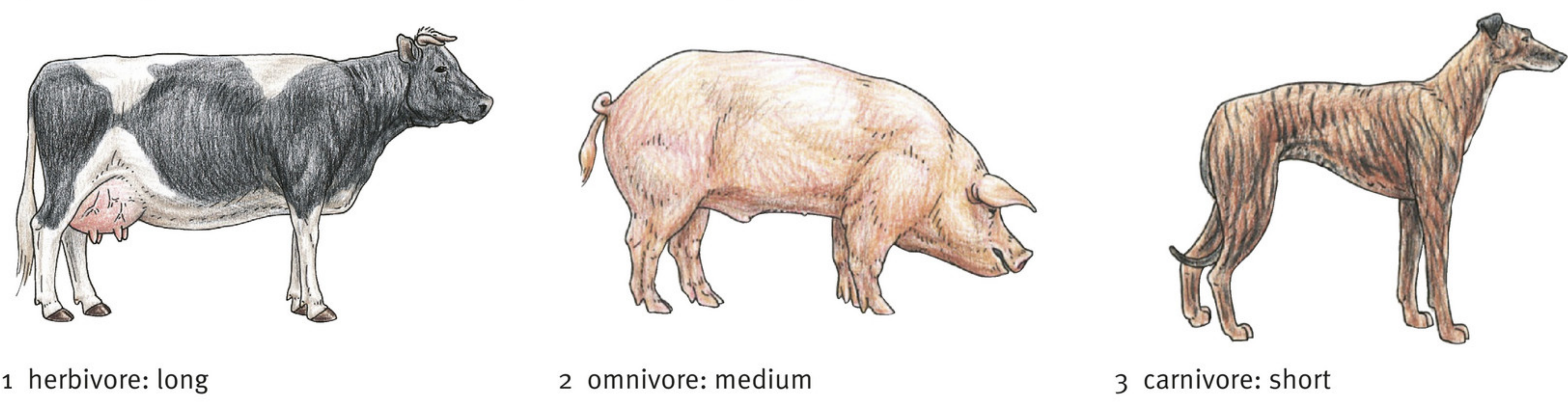
Mammals that only eat plants are called **herbivores**. Ones that only eat other animals are called **carnivores** and mammals that eat both plants and animals are called **omnivores**. There are differences between the digestive systems of herbivores, carnivores and omnivores.

Vegetable matter is more difficult to digest. This is because plant cells have cell walls. The cell walls contain the substance cellulose. This substance is difficult to digest. Because there are no cell walls in animal foodstuffs, they are easier to digest.

HERBIVORES

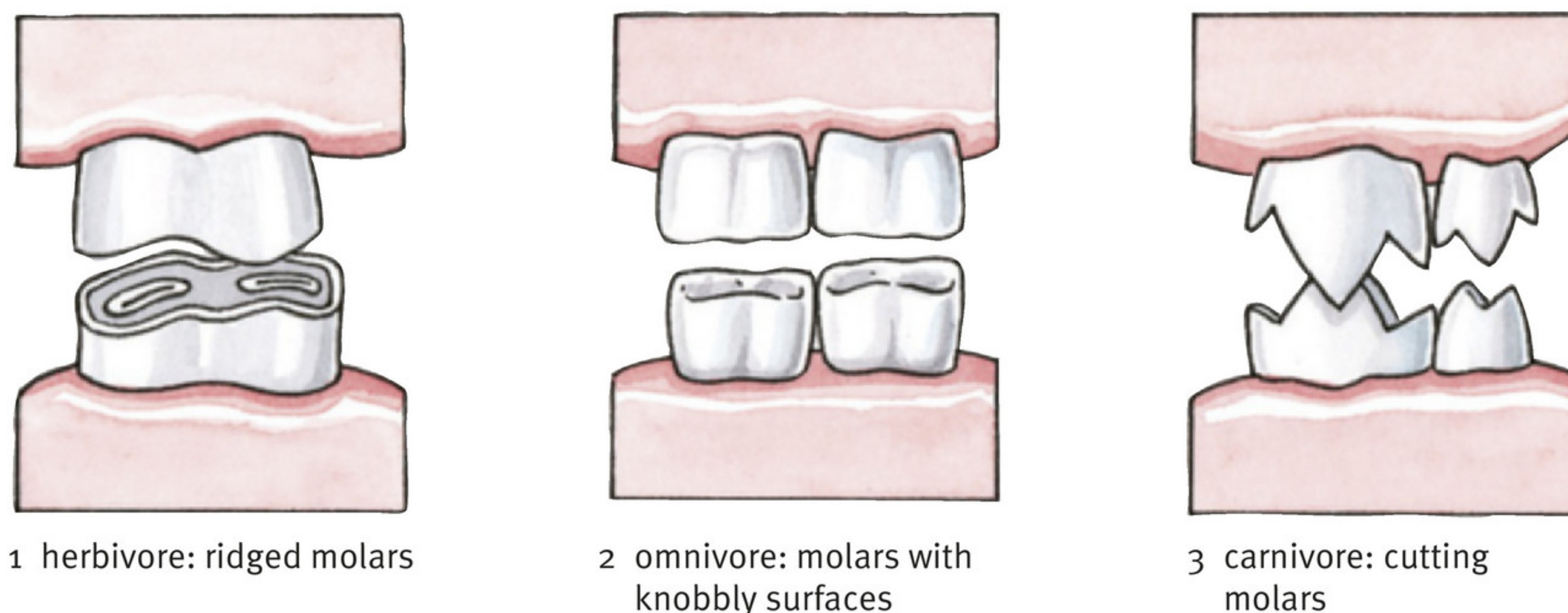
Plant eaters are referred to as herbivores. They have a relatively long intestinal tract compared to their body length. The intestines of a cow, for example, are forty metres long. That is about twenty-five times as long as the body. As a result, the animal's girth is relatively large in comparison to its body length (see figure 1.1). The long intestinal tract is needed for digesting the cell walls of plant cells.

fig. 1 Length of the intestinal tract, compared to the body length.



Herbivores have **ridged molars** (see figure 2.1). These are molars with tough ribs of enamel. As the animal chews, the food is crushed fine between the ridges (see figure 3). The ridges are perpendicular to the direction of the chewing motion. Herbivores often do not have canines.

fig. 2 Molars.



CARNIVORES

Meat eaters are referred to as **carnivores**. Carnivores do not have to digest the cell walls of plants. That is why they have a relatively short intestinal tract compared to their body length. In a dog, for example, the intestinal tract is about five and a half times as long as the body. The body can therefore have a slender shape (see figure 1.3).

Carnivores have **cutting molars** (see figure 2.3). These are sharp teeth that can cut the food into pieces so that it can be swallowed quickly. The upper jaw is wider than the lower jaw, so that the molars slide past each other, shearing like a pair of scissors. The canines are mostly large, pointed and sharp (see figure 3). They are used for killing prey and tearing off chunks of meat. They can also be used for defence.

fig. 3 Cutting molars and canines in dogs (carnivores).



OMNIVORES

Animals that eat both plant and animal matter are referred to as **omnivores**. One example of an omnivore is a pig (see figure 1.2). The intestinal tract in omnivores is medium length in comparison to the body length. Omnivores have molars that have a **knobby** face (see figure 2.2). The molars have a surface that allows the food to be ground up. Omnivores generally do have canines. In some omnivores, they are large, pointed and sharp (see figure 4). They are then used for killing prey. In other omnivores, the canines are much the same size as the incisors. Humans are also omnivores and we have molars with knobby faces. But we cut our food up smaller with knives too and process it by cooking. This helps us digest part of our vegetable diet.

fig. 4 Large canines and molars with knobby surfaces in a monkey (omnivore).



KNOWLEDGE

1

Which belong together?

- A eats plants and meat

☐
- B plant eater

☐
- C meat eater

☐
- ☐ 1 carnivore
- ☐ 2 herbivore
- ☐ 3 omnivore

2

Mammals feed on plants and/or animals.

- a What food is easier to digest: plant-based or animal-based? Explain your answer.
- b How long is the intestinal tract in comparison to the body length?

- A carnivore

☐

☐ 1 short
- B herbivore

☐

☐ 2 medium long
- C omnivore

☐

☐ 3 long

3

Complete. For the molars, use: *cutting – knobbly – ridged*. For the canines, use: *no – large – large or small*.

- An omnivore has molars and usually has canines.
- A herbivore has molars and usually has canines.
- A carnivore has molars and usually has canines.

4

Summary

Complete the table.



Type of animal	Meat eater and plant eater	Plant eater	Meat eater
Alternative name			
Length of the intestinal tract compared to the body length			
Type of molars			
Function of the molars			
The structure of the molars or the jaw			
Canines			

INSIGHT

5

- Figure 5 is a picture of three skulls.
- In which skull is the upper jaw wider than the lower jaw? in skull 1 / 2 / 3
 - In which animal is the intestinal tract long in relation to its body? in the animal with skull 1 / 2 / 3
 - In which skull can you see molars with knobbly surfaces? in skull 1 / 2 / 3

fig. 5 The skulls of three animals.



skull 1



skull 2



skull 3

6

Table 1 gives the composition of the feed for three pets. What types of molars do the pets have?

- A guinea pig ☐ 1 cutting molars
- B cat ☐ 2 knobbly molars
- C pet rat ☐ 3 ridged molars

Table 1 Composition of the food for three pets.

Pet	Food composition
Guinea pig	grain, dried fodder, byproducts of seeds, oily seeds, dried herbaceous plants and fruits, vegetable byproducts, minerals, vitamins
Cat	grains (2%), vegetable byproducts (3%), tuna (67%), milk and milk byproducts (9%), egg and egg products (17%), minerals, yeast, vegetable protein extracts
Pet rat	grain products and byproducts, seeds/pulses, oily seeds, fish products, oils and fats, high-fibre products, chicken stomach, minerals, nuts

7

- a Humans are omnivores, just like many species of primates. Primates that are omnivores have stronger jaws and teeth and molars in relation to their bodies than humans. Explain why.
- b Primates can also be herbivores or omnivores. What do you expect a proboscis monkey to be: an omnivore or a herbivore (see figure 6)? Write down what characteristic tells you that.

fig. 6 Een neusaap.



8

- a Find out what the difference is between vegetarians and vegans, for example in a dictionary or on the Internet. What is the difference?
- b Are vegetarians herbivores? What about vegans? Explain your answer.

+ 9

Two dogs are given different types of dog food. The compositions of these two types of dog food are given in table 2. The quantity of faeces produced by a dog depends on the type of food that the dog gets.
Which dog will produce more poo? Explain your answer.

Table 2 The composition of two types of dog food.

	Composition
Dog food 1	fresh chicken (26%), dried poultry (9%), potato (15%), sweet potato, beet pulp, dried algae (4%), dried egg, chicken stock, beer yeast, minerals, linseed (1.2%), seaweed, beta-glucans, dried cranberries (0.04%), dried apple (0.04%), dried pear (0.04%), dried broccoli (0.04%), dried tomato
Dog food 2	35% beef, 10% beef heart, 10% carrot, 9% beef tripe, 8% beef breastbone, 6% beef kidney, 3% freeze-dried beef liver, 4% apple, 4% pear, 3% beet, 2% blueberries, 1% sunflower oil, 0.8% cod liver oil, 0.5% wheat germ oil, 0.4% salmon oil, 0.4% rose hip powder, 0.4% algae calcium, 0.1% dried seaweed

HOW IT FITS TOGETHER the world we live in

GREATEST BITE FORCE

Crocodiles have the greatest bite force of all animals. They can close their jaws with a force of several thousand kilograms. They need that when they are killing antelopes, fish, zebras or young hippos. Crocodiles can even bite through the shells of turtles.

Smaller prey is swallowed whole by the crocodile. Larger animals, such as buffalos and antelopes, are dragged into the water. After that, the crocodile twists lengthwise really quickly with the prey in its mouth. This tears the bigger prey into pieces. A crocodile cannot grind the meat between molars.

No animal should want to end up between the jaws of a crocodile, but there is one animal that – according to legend – does dare to: the crocodile bird (*Pluvianus aegyptius*). The story goes that this bird relieves the Nile crocodile of meat residues stuck between its teeth, with the crocodile bird walking between the crocodile’s jaws. A crocodile’s teeth are covered in a layer of bacteria, and having clean teeth reduces the risk of inflamed gums significantly. According to biologists, such a collaboration is possible but they have never actually witnessed this ‘tooth picking’.

fig. 7 A Nile crocodile eating an antelope.



10

- Read the text the ‘Greatest bite force’.
- a** What nutrients does a crocodile mostly digest? *proteins / carbohydrates / fats*
 - b** What direction or directions does a crocodile move its lower and upper jaws with respect to the other: opening and closing, side to side, or both? Explain your answer.
 - c** What animal has the least amount of intestinal bacteria in relation to its bodyweight: a rabbit (herbivore), a crocodile (carnivore) or a pig (omnivore)? Explain your answer.
 - d** A prey animal that is bitten by a crocodile and then escapes often dies anyway. Sometimes it is because the prey animal bleeds to death, but the cause can also be an infection. Explain how this infection occurs.

How it fits together

FLATULENCE FOR DUMMIES

You are only likely never to suffer from flatulence if you eat nothing but pasta, pizza and white bread every day. ‘Flatulence’ means passing wind. In other words: farting. What is flatulence and how do you get rid of it?

FIBRE BOMBS

You pass wind every day if you’re healthy. It releases the gas created in your digestive system. Some gas ends up there when you swallow air or drink soft drinks with carbon dioxide, but it is mostly produced by the bacteria in your large intestine. Together, they weigh up to two kilograms and live off leftover food that could not be digested in your small intestine: dietary fibre. This fibre is a nice meal for the bacteria. Brown beans, for example, are real fibre bombs: almost 10% of them is fibre. And broccoli, berries, nuts and even some sugar substitutes have a lot of fibre as well. When the fibre is digested, your intestinal bacteria produce gas. And you have to get rid of that gas from your intestines somehow.

So should you stop eating fibre? Bad idea! That’s why you should take good care of your intestinal bacteria. As well as gas, the bacteria also produce vitamins and healthy fatty acids. They also boost your resistance to disease and displace more harmful bacteria. If you never eat fibre, you are more likely to get sick. The Netherlands Nutrition Centre recommends eating 14 g dietary fibre per 1000 kcal per day. If you start eating more dietary fibre, you should build that up slowly, because your intestinal bacteria need to get used to their new diet.

FIFTEEN A DAY

Needless to say, it is an uncomfortable situation if you have to pass wind when other people are around. The good news is that everyone does it, fifteen times a day on average. Even in your sleep, gas escapes from your intestines. Some wind does not even smell. So it’s better not to hold it back. The gas ends up back in your blood, after which it ultimately comes out through... your mouth. You’d rather fart, wouldn’t you? Holding back wind can even cause inflammation in your intestines. The best solution is to find a quiet spot to pass wind.

If you want to reduce flatulence healthily, you should drink less soft drinks. Don’t eat too much meat or onions in one go either, because those make the bacteria produce a lot of rotten-egg smell. But do keep passing wind. If you never have to pass wind, you are neglecting your intestinal bacteria.

After: Enders, G. (2014). ‘De Mooie Voedselmachine, De Charme van je Darmen.’ Uitgeverij Luitingh-Sijthoff BV.

fig. 1



fig. 2



EXERCISES

1

- a** How could you change your diet to take better care of your intestinal bacteria?
- b** How many grams of fibre should you eat every day, according to the Netherlands Nutrition Centre?
- c** Which section of the Wheel of Five do you mostly eat from if you only eat white bread, pizza and pasta?
 - ☐ A green (vitamins)
 - ☐ B yellow (fats)
 - ☐ C pink (proteins)
 - ☐ D orange (carbohydrates)
 - ☐ E blue (water)
- d** Eating wholemeal pasta makes you pass more wind than eating white pasta. Explain why.
- e** If you chew brown beans extra well or grind them up in a food processor, you will have less flatulence. Explain why.

2

Table 1 gives the nutritional value of two products: a real steak and a vegetable alternative to steak that looks almost the same.

- a** Which of the two is the real steak? Explain your answer.
- b** Which of the two produces the most gas in your intestines after you eat it? Explain your answer.
- c** What digestive juices mainly break down meat?
- d** Cows pass more wind than dogs and the dog farts are smellier than those of cows. Explain why.

Table 1 Nutritional values of two products.

Nutritional value per 100 g	Product A	Product B
Energy	222 kcal	127 kcal
Fat	12.7 g	3.5 g
• Saturated fat	5.0 g	0.7 g
Carbohydrates	7.8 g	0.0 g
Fibre	3.6 g	0.0 g
Protein	17.3 g	23.8 g
Vitamin B12	0.38 µg	1.6 µg
Iron	2.1 mg	2.2 mg

Source: voedingswaardetabel.nl

3

Wind can be released with a lot of noise or very little.

- a** What muscle relaxes when you pass wind?
- b** One of the gases released when passing wind is carbon dioxide. Is carbon dioxide a nutrient? Explain your answer.
- c** How can gas from your intestines get into your lungs?

d What route does wind you have held in take if it exits through your mouth?

- blood vessel
- large intestine
- small intestine
- pharynx (throat)
- pulmonary vein
- alveoli
- pulmonary capillaries
- windpipe
- oral cavity (mouth)

4

Pancreatic juice neutralizes hydrochloric acid so that it is no longer harmful to bacteria. Why is that important to your microbiome (the bacteria in your intestines)?

5

Inulin is a common additive. Bakers use it in bread and pastries, for instance. It is a white-coloured substance that makes you feel full without making you gain weight. In the Netherlands, inulin is obtained from Cichorium, a plant from the chicory family.

a What kind of a nutrient is inulin?

- ☐ A protein
- ☐ B carbohydrate
- ☐ C mineral
- ☐ D fat
- ☐ E vitamin

b Is inulin a natural or artificial additive? Explain your answer.

c Inulin is often used as a sugar substitute.

Explain why many vegetable sugar substitutes cause extra flatulence.

7

Thinking about food

LEARNING OBJECTIVE
2.7.13 You can explain why eating less meat is good for your health and for the environment.

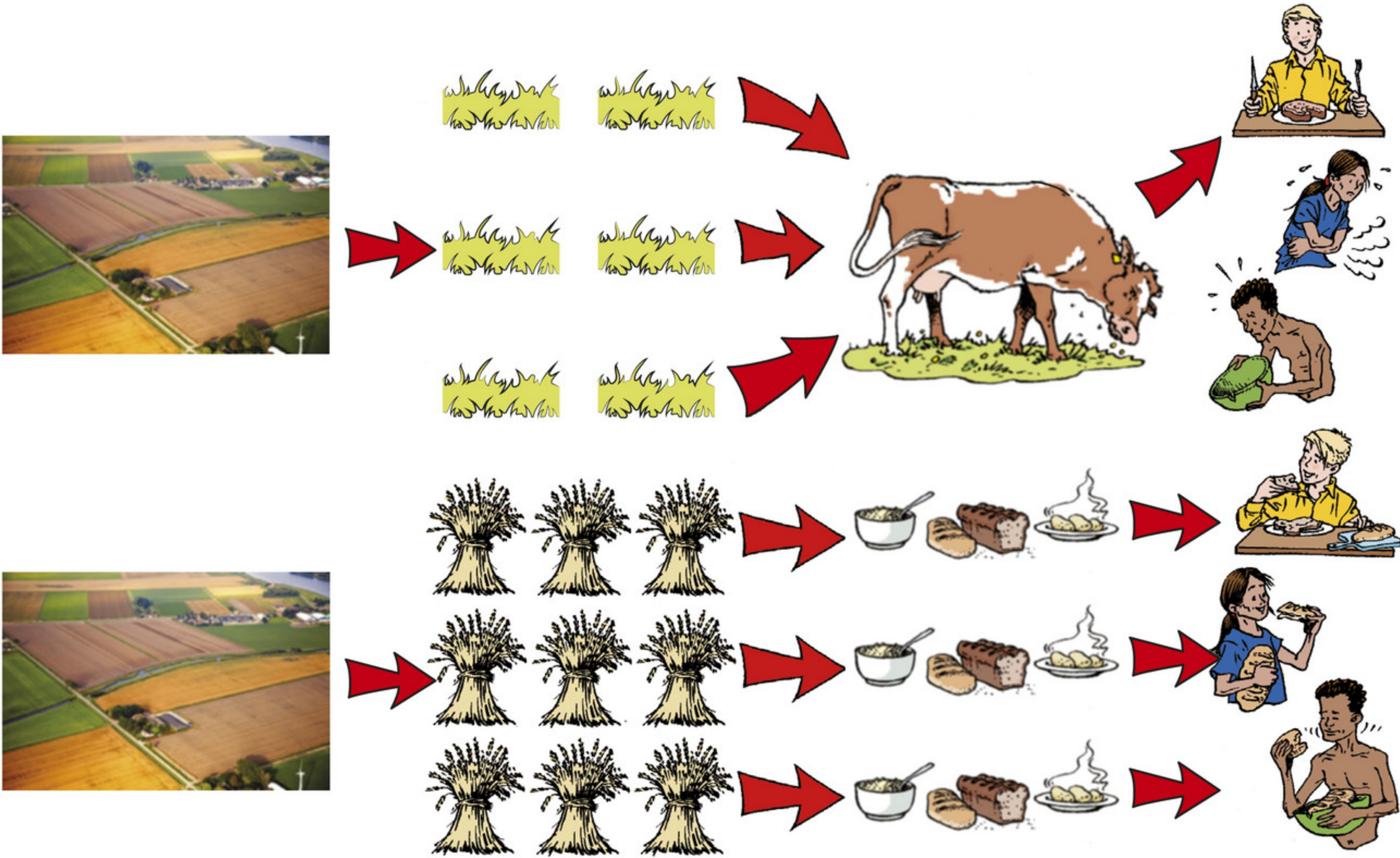
TAXONOMY	LEARNING OBJECTIVE AND EXERCISES
	2.7.13
Remembering	
Understanding	1a, 2, 3
Using	1b, 4ab
Analysing	4c, 5

There are still countries where people (mostly children) die of hunger. That is despite there being enough food for everyone on the planet. The food is however not equally distributed.

PROTEINS
There are countries where so much food is produced that some of it has to be destroyed. That happens in the Netherlands too. Sometimes good, healthy food gets used as animal feed. On the other hand, malnutrition due to protein deficiency is common in many developing countries. If there is not enough protein in their food, people will start feeling weak and tired. In time, they will become ill. Proteins are mainly found in animal products such as meat, dairy and eggs, and in pulses (beans) and nuts.

Cows eat mainly grass and maize. For every kilogram of animal protein that a cow gives, that animal may have needed to eat as much as ten kilograms of plant protein. We can't eat grass though, can we? That's true, but the agricultural land where we grow grass and maize for cows could be used to grow products that we can eat (see figure 1).

fig. 1 Plant and animal protein.



EAT LESS MEAT

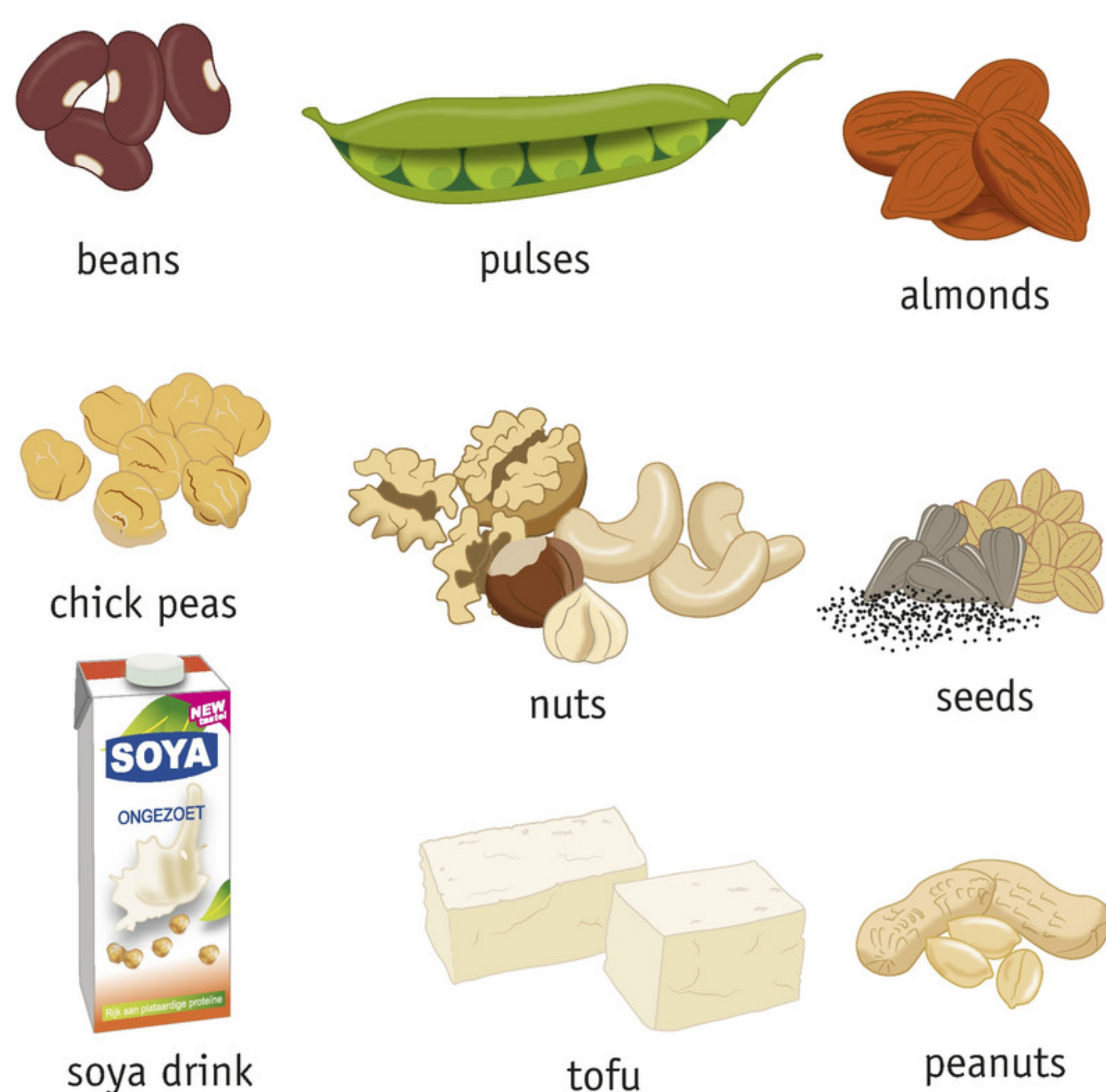
Vegetarians are people who do not eat any meat. Some ‘vegetarians’ will not eat the meat of mammals or birds but will eat fish and other marine animals. **Vegans** do not consume any animal-based products at all, including milk, eggs or cheese. **Flexitarians** are people who choose to eat meat every now and then.

There are lots of reasons for not eating meat or for eating less of it. The most important are respect for animals, your health, the environment and the food question: how can we make sure that all people get enough to eat, both now and in the future?

Many vegetarians are against killing animals or against the way that animals are kept and treated. Some people are vegetarians because of their religious beliefs. There are also people who do not eat meat because they do not like the taste or because they think it is too expensive. Others are vegetarians for health reasons. Meat contains useful nutrients such as proteins, B vitamins and iron. But if you eat too much meat, it can in fact be bad for your health. Eating a lot of red meat and processed meat (such as sausages or hamburgers) can increase the risk of stroke, type 2 diabetes, colon cancer and lung cancer.

You may also choose to eat little or no meat for the sake of the environment. Food is responsible for 20 to 35% of all greenhouse gas emissions, more than half of which come from meat and dairy. Eating less meat brings many environmental benefits. That is because a lot of land, water and feed are needed to keep livestock. The fodder also has to be grown and transported. Moreover, the animals themselves produce a lot of greenhouse gases through burping, flatulence and manure.

fig. 2 Pulses, nuts and meat substitutes instead of meat.



SUBSTITUTING MEAT

Meat in your meals can be replaced by other high-protein products such as pulses and nuts. This reduces the risk of chronic diseases (diseases from which you never recover). The impact of pulses, eggs and nuts on the environment is also a lot lower. The climate impact of pulses can be twenty times lower than for beef. One disadvantage is that the body absorbs iron from these foodstuffs less easily. Vitamin C helps the body absorb iron. This is why you must eat plenty of fruit and vegetables if you are a vegetarian. Vitamin B12 hardly occurs at all in plant-based foodstuffs, although it is present in milk and dairy products. There are also vitamin B12 tablets that vegetarians can take.

You can also find **meat substitutes** in the supermarket. These products often look like meat – not only in their outward appearance but also in taste, texture and nutritional value. Most meat substitutes are made from soy beans or from cereal proteins (see table 1). Some meat substitutes have added iron, protein and B vitamins.

Table 1 Nutritional value of meat and vegetarian alternatives.

	Protein (per 100 g)	Iron (per 100 g)	Vitamin B1 (per 100 g)	Vitamin B12 (per 100 g)
Pulses (beans, prepared)	7.5 g	2.0 mg	0.0 mg	0.0 µg
Tofu	12 g	2.0 mg	0.06 mg	0.0 µg
Egg (boiled, average)	12.9 g	2.1 mg	0.01 mg	1.1 µg
Quorn	14.0 g	0.7 mg	0.10 mg	0.2 µg
Mince (mixed pork and beef)	17.5 g	1.5 mg	0.18 mg	1.5 µg
Seitan	22.1 g	1.9 mg	0.03 mg	0.0 µg
Nuts (mixed)	22.7 g	3.3 mg	0.18 mg	0.0 µg
Cheese (full fat)	24.5 g	0.3 mg	0.03 mg	1.5 µg
Steak	28.3 g	2.0 mg	0.04 mg	1.8 µg

EXERCISES

1

- a What reasons might people have for eating less meat or no meat? Write down at least five.
- b Read the text ‘Why have a meat-free day?’ in figure 3. The environment is mentioned as one reason for eating less meat or no meat.
What arguments other than energy consumption are given in this context?

fig. 3

Why have a meat-free day?

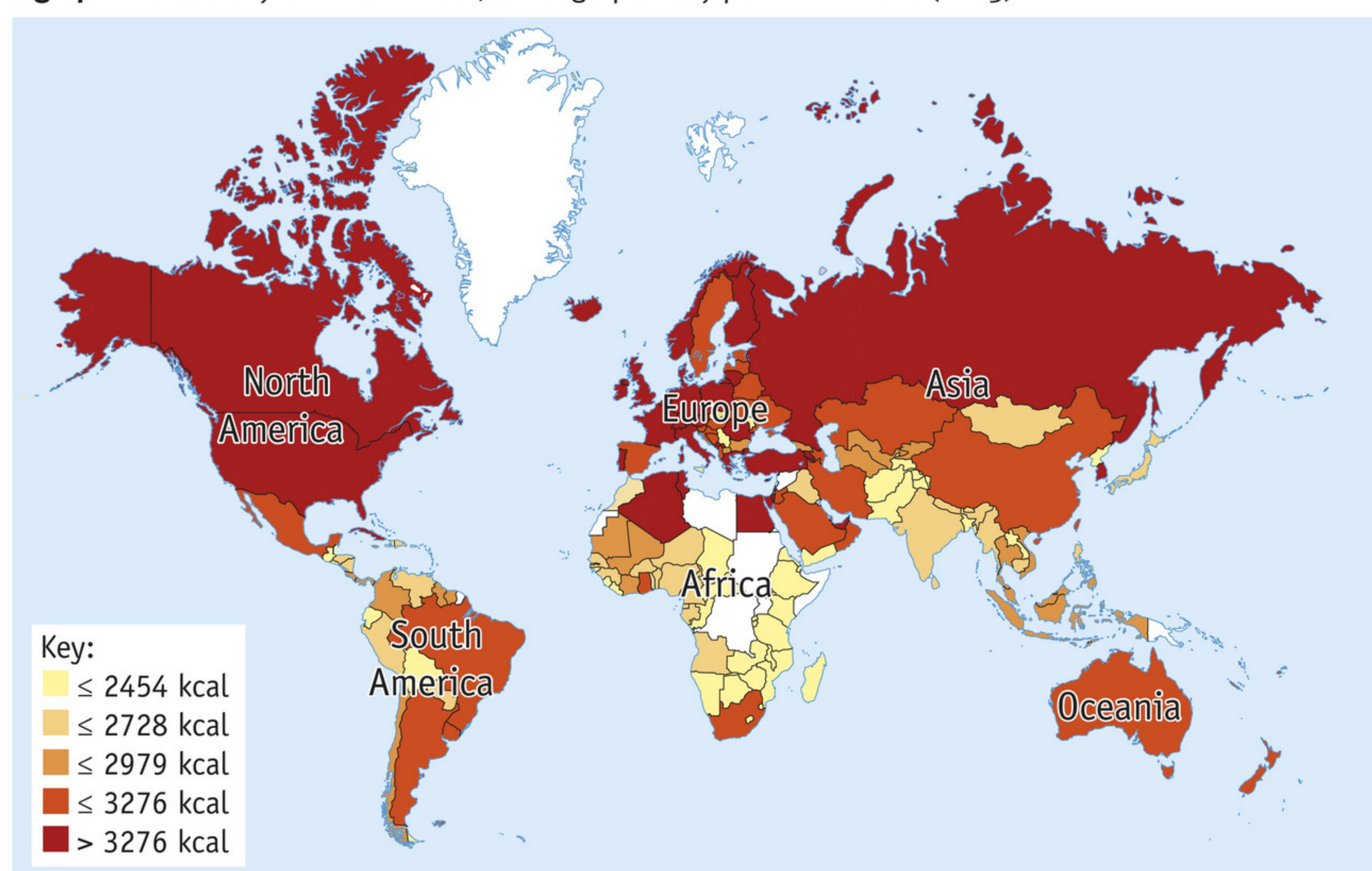
Did you know that having one meat-free day a week is very healthy? Dutch people eat 200 g of meat and processed meat products a day on average, whereas the Netherlands Nutrition Centre recommends eating a maximum of 500 g of meat per week. There are many good meat substitutes with tasty seasonings. So you can still have a kebab sandwich made from meat substitutes on your meat-free day. A meat-free day is not just healthy, it is also very good for the environment. If you don’t eat meat one day a week, you save a lot of energy. It has more effect than a house full of energy-saving lamps or an energy-efficient car. It also has a beneficial effect on water consumption. As much water is needed for producing one kilo of steak as for 1300 showers!

2

Figure 4 shows how much food is available per day for people in various countries throughout the world.

- a** In which three parts of the world can people eat the most?
- ☐ A Africa
 - ☐ B Asia
 - ☐ C Europe
 - ☐ D North America
 - ☐ E Oceania
 - ☐ F South America
- b** The average food intake per head of the population in Venezuela is 2517 kcal per day. Can you therefore conclude that everyone in Venezuela has enough to eat? Explain your answer.

fig. 4 Availability of food in kcal, average per day per inhabitant (2013).



Source: FAO (Food and Agriculture Organization of the United Nations), Food Balance Sheets.

3

- a** What two nutrients might you get a deficiency of if you don't eat meat?
- b** What can you do to make sure that you still get enough of these nutrients? Give your answer for each nutrient that you wrote down in Question (a) separately.

4

- a** In Sudan, 13% of the food intake is protein, the same percentage as in the Netherlands. However, the amount of protein people consume in Sudan is much less than in the Netherlands, at 71 g/day compared to 112 g/day. Explain why that is.
- b** In the Netherlands, our food is (on average) too rich in protein, while people in many developing countries are malnourished due to a lack of protein. Some people claim that there would be no more hunger in developing countries if everyone was vegetarian. Explain this using figure 1.
- c** Some people call eating meat a type of food wastage. Explain why. Think about the use of nutrients in your body.

5

Cultured meat is cultivated in a laboratory from animal stem cells. The process is too expensive as yet for selling cultured meat in the shops, but that may change in the future. Protein from the blood of calves is used as building blocks in producing this cultured meat. Researchers are investigating whether protein from cultivated algae could be used instead.

Explain why using proteins from algae is better for the world food situation than using protein from calves.

 Go to the *Flash cards*.

8

Product information

LEARNING OBJECTIVE

2.8.14 You can explain the information on food product packaging.

TAXONOMY	LEARNING OBJECTIVE AND EXERCISES
	2.8.14
Remembering	1a
Understanding	1b, 2
Using	3, 4
Analysing	

The packaging of foods gives all sorts of information. To make good and healthy choices, you must be able to read and understand this information.

THE SMALL PRINT

The packaging of food gives information about its contents. This is called **product information**. The manufacturer is legally required to state the name of the product, the name of the manufacturer, the net volume, the ‘best before’ date and the list of ingredients on the packaging.

The packaging must also give a number: the **production code** or **batch code**. This is to let them trace exactly when and where a product was made. In the event of the food being contaminated, the manufacturer can then see what other packages were probably contaminated too.

After the volume, you will often see a large letter ‘e’ (see figure 1.2). That ‘e’ is the first letter of the word **estimate** (an estimated volume). The actual volume may not differ from the stated volume by more than a given amount.

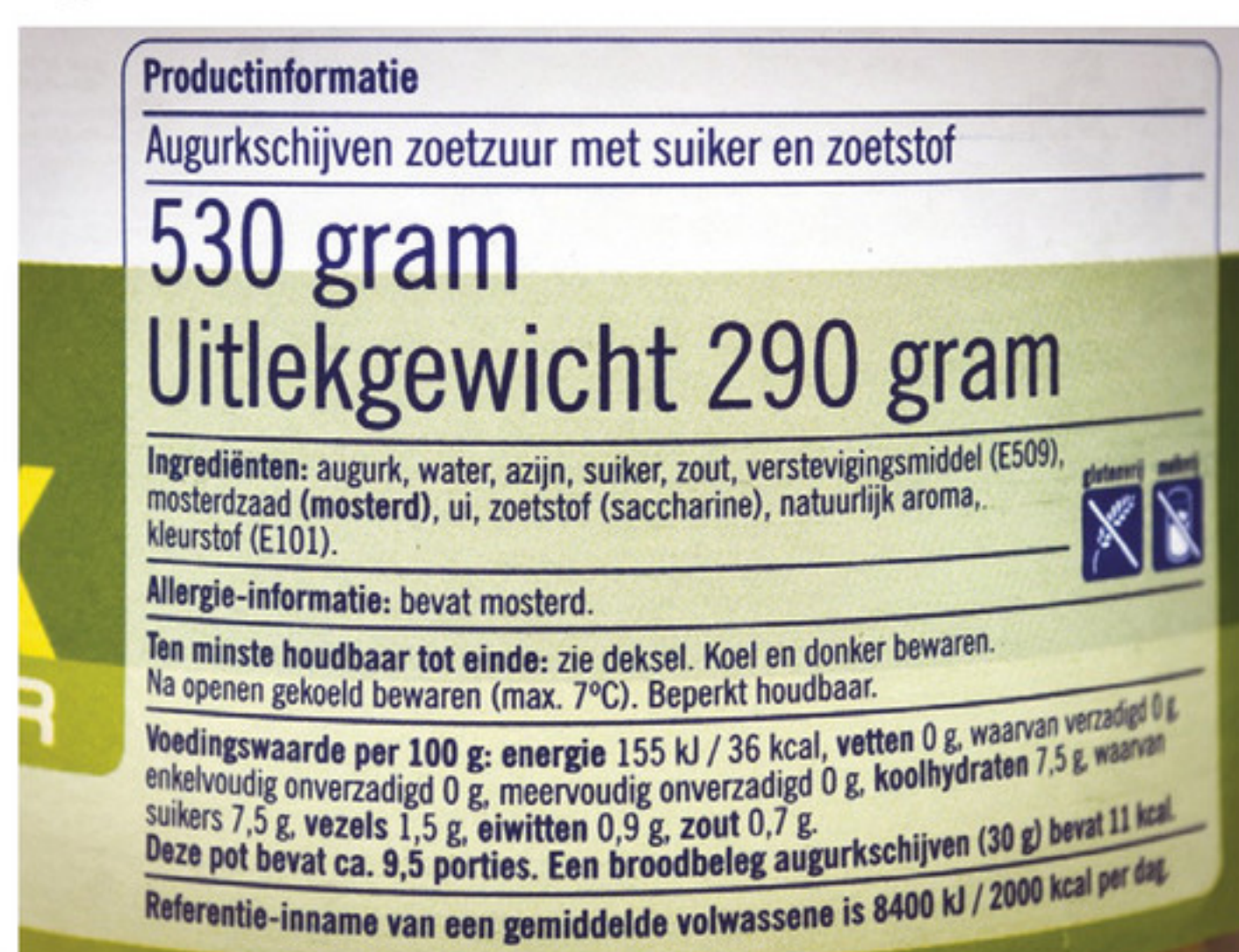
Packaged foodstuffs that do not spoil very quickly have ‘best before’ and a date on the packaging. The **best before date** is called the ‘THT’ date in Dutch. Until that date, the manufacturer guarantees the product quality, as long as it has been stored correctly in the closed packaging. You can usually still eat the product safely after the best before date.

Perishable foods such as milk have a ‘use by’ date. This **use by date** is called the ‘TGT’ date in Dutch. Meat, meat products and other produce that can spoil quickly should definitely not be kept beyond the date indicated. The **storage instructions** tell you how to store the product. The ‘use by’ date is the last day on which you can safely eat the product. After that date you should throw the product away.

The **ingredients** are the raw materials that the product is made from. They are listed on the packaging in sequence of decreasing quantity in the product. The list of ingredients also states the additives or other auxiliary materials added. Additives that do not present any danger to health are given **E numbers** (see figure 1.1). These substances are allowed to be used in all European countries.

Some people may be hypersensitive (allergic) to certain additives. They can then use the E numbers to see if they will be able to tolerate a particular food. Additives that only have a number (without the E) are only permitted in some European countries.

fig. 1 Product information.



1 gherkins



2 tomato ketchup

It is becoming increasingly common for the manufacturers to state the **nutritional value** of the product too (see figure 2). The packaging then states how much energy, fat, protein, carbohydrate and salt are in the product, usually per 100 g or per 100 mL. Minerals and vitamins are sometimes listed too. The amount of energy is usually quoted in both kilojoules and kilocalories.

fig. 2 The nutritional information included in the product information.

en 172 kJ. Roer de soep even door en verwarm niet. Roer de soep nogmaals circa 1 minuut. Roer de soep vervolgens nog een keer door. Eet smakelijk!

Na opening van het blik is deze soep afgedekt 2 dagen houdbaar in de koelkast.

Voedingswaarde	Per 100 ml	Per kom 250 ml	% GDA (250 ml)
Energie	230 kJ (55 kcal)	580 kJ (140 kcal)	7%
Eiwitten	2 g	5 g	
Koolhydraten	8,5 g	21 g	16%
waarvan suikers	5,5 g	14 g	6%
Vet	1,5 g	4 g	5%
waarvan verzadigd vet	0,4 g	1 g	
Voedingsvezel	1 g	2,5 g	37%
Natrium	0,35 g	0,89 g	

* van de Dagelijkse Voedingsrichtlijn (GDA) op basis van 2000 kcal

Vragen, klachten of

EXERCISES

1

A lot of foods have a ‘use by’ or ‘best before’ date.

a Which belongs with the following sentences?

- The manufacturer guarantees the quality until this date.
- After this date you can often still safely eat the product.
- After this date you should throw the product away.
- The product has storage instructions.
- Meat and meat products have this date.

use by / best before
use by / best before
use by / best before
use by / best before
use by / best before

b What products have a 'use by' date?

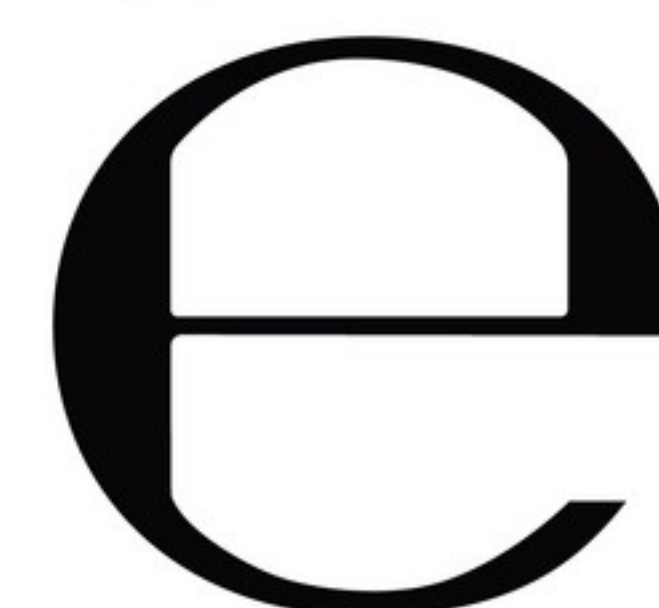
canned vegetables / crisps / mince / milk / rice / fresh salmon

2

Figure 3 shows a symbol that can be found on some labels. What does this 'e' mean?

- ☐ A You can find the product's ingredients listed after this letter.
- ☐ B The amount of energy is quoted in both kilojoules and kilocalories.
- ☐ C The volume in the packaging is roughly the specified quantity.
- ☐ D This additive was approved by the European Union.
- ☐ E This product has additives that you may be allergic to.

fig. 3



3

- a** Figure 1.1 shows the label of a jar of gherkins. It says '530 grams. Drained weight 290 grams.'
- How many grams of gherkins are in the jar?
- b** Figure 4 shows the label for a packet of chocolate sprinkles.
- What ingredient do the chocolate sprinkles have the highest amount of? Explain your answer.

fig. 4 Information on a packet of chocolate sprinkles.



Ingrediënten: suiker, 20% magere cacaopoeder, cacaooboter, cacaomassa, emulgator (lecithine), glansmiddel (arabische gom). Cacaobestanddelen ten minste 32%.

Allergie-informatie: gemaakt in een bedrijf waar ook melk wordt verwerkt.

Ten minste houdbaar tot einde: zie bovenzijde. Koel, donker en droog bewaren.

Voedingswaarde per 100 g

energie	1875 kJ / 445 kcal
eiwit	5,0 g
koolhydraten	67 g
waarvan suikers	65 g
vet	16 g
waarvan verzadigd	9,5 g
onverzadigd	6,5 g
transvet	0 g
voedingsvezel	7,5 g
natrium	0,03 g
toegevoegd zout	0 g

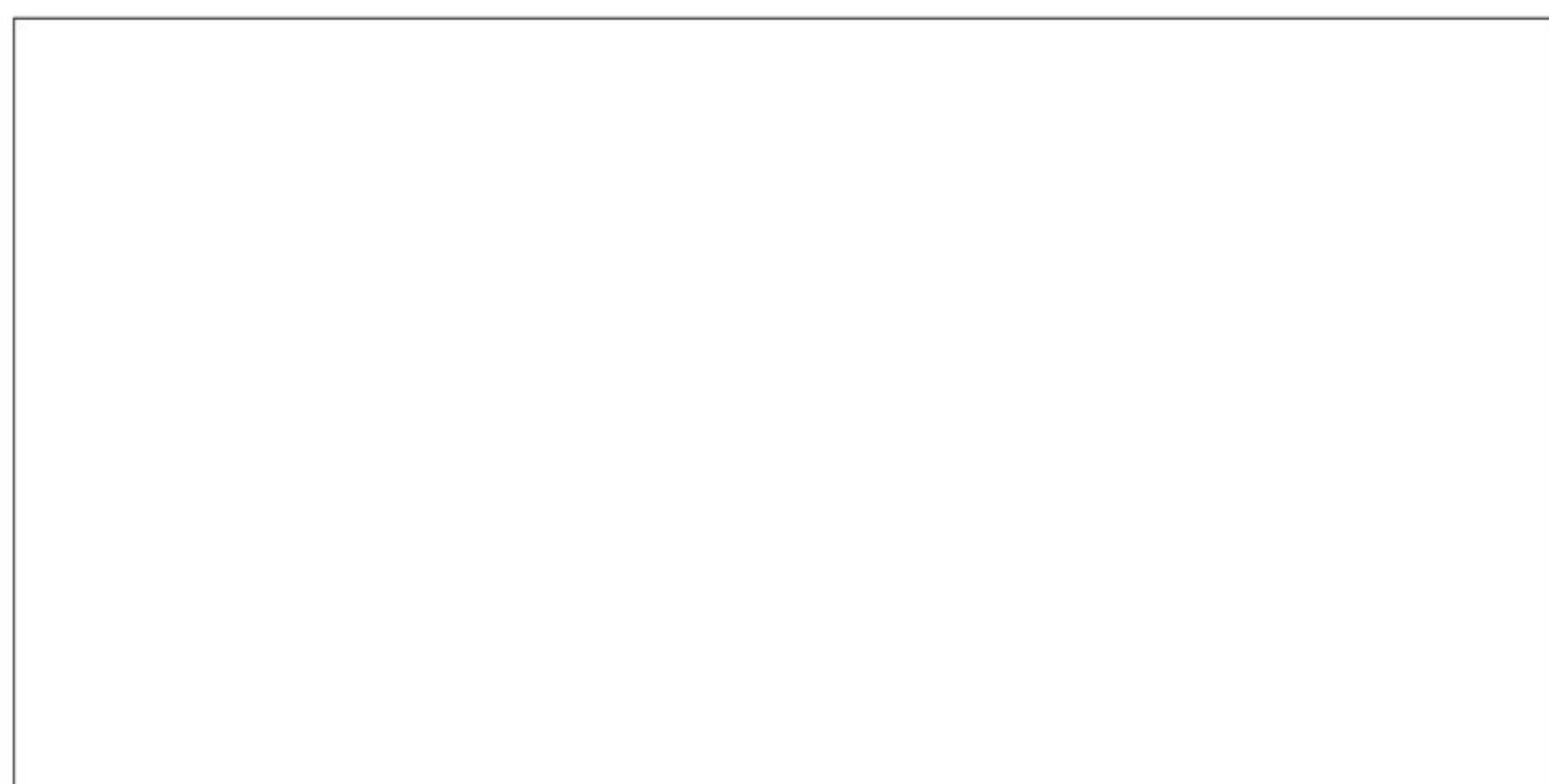
Een broodbeleg Xtra grote hagel puur (15 g) bevat 67 kcal.

4

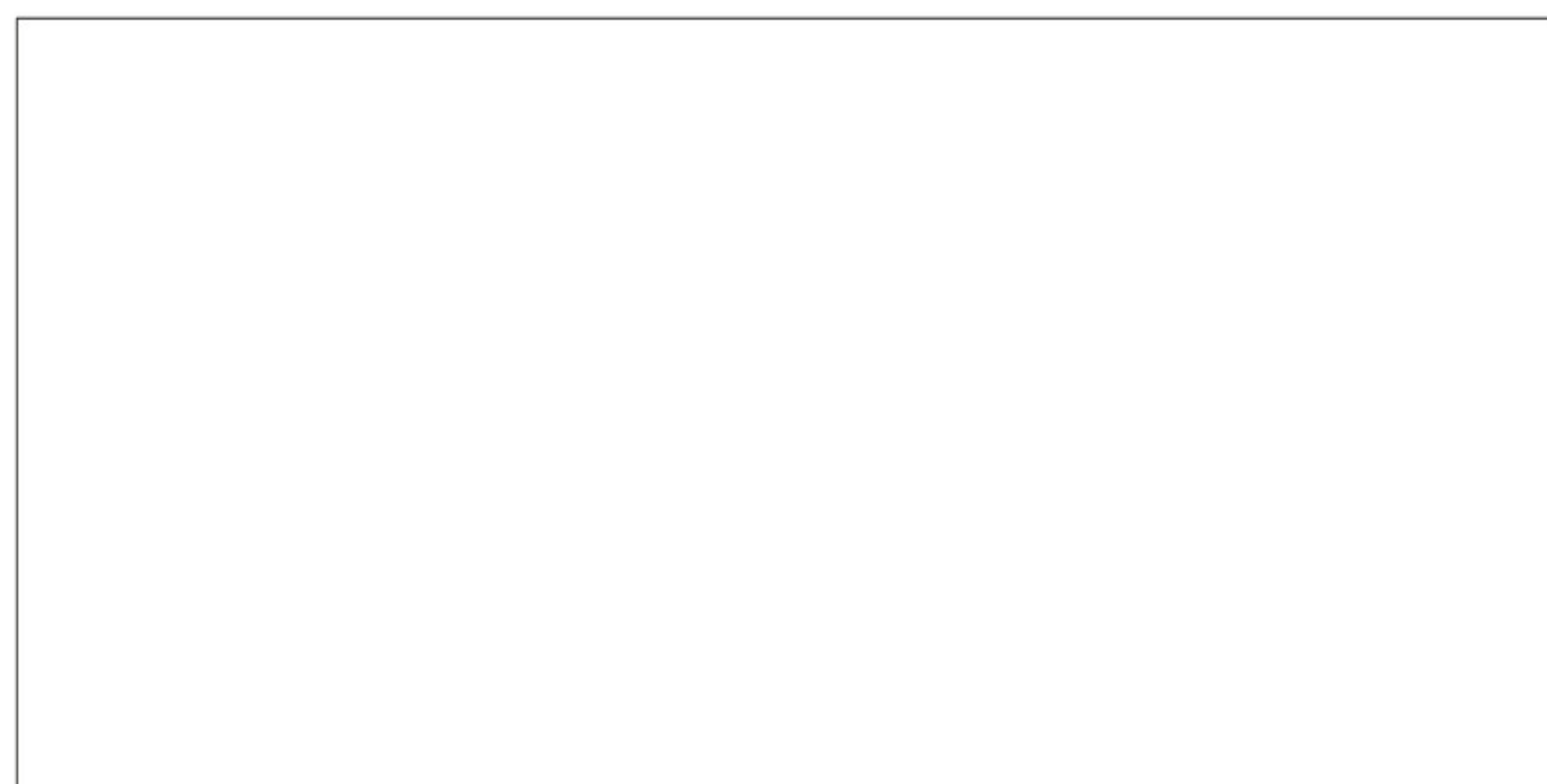
- Take the labels of two foodstuffs that you use a lot at home.
- Stick the labels in the two spaces.

Answer the following questions about the two labels separately.

- 1 What is the name of the product?
- 2 What is the name of the manufacturer?
- 3 What is the net contents?
- 4 How should the food be stored?
- 5 What is the product's 'best before' date?
- 6 What are the ingredients of the foodstuff?
- 7 What additives are there in the foodstuff?
- 8 Which of these additives are permitted in all European countries?
- 9 Is the nutritional value given on the label?



label 1



label 2

 Go to the *Flash cards*.

Learning how to do research

1

DETECTING THE NUTRIENTS

► Basics 1 | ► Learning objectives 2.O.15 and 2.O.16 | ► Practical activities 1, 2 and 3

NUTRIENTS

The nutritional content of most foodstuffs has already been determined. The details are stated on the packaging (see figure 1). You can test some foodstuffs yourself to see what nutrients are in them. You are going to do that for glucose and starch.

fig. 1

Gemiddelde voedingswaarde			
	Per 100 g	1 Portie (75 g)**	% (75 g)*
Energie	1511 kJ 357 kcal	1133 kJ 267 kcal	14 % 14 %
Vetten	2,1 g	1,6 g	2 %
- waarvan verzadigde vetzuren	0,5 g	0,4 g	2 %
Koolhydraten	75 g	56 g	22 %
- waarvan suikers	0,5 g	<0,5 g	<1 %
Vezels	3,4 g	2,5 g	
Eiwitten	8,2 g	6,2 g	12 %
Zout	<0,01 g	<0,01 g	<1 %

*Referentie-inname van een gemiddelde volwassene (8.400 kJ / 2.000 kcal).
**1 Portie = 75 g Zilvervliesrijst.

INDICATORS FOR GLUCOSE AND STARCH

You can use test for glucose using test strips as the indicator (see figure 2). There is a substance on the test strip that changes colour. A doctor may use the same test strips for testing for glucose in urine. You test for starch using iodine solution as the indicator (see figure 3).

fig. 2 Testing for glucose.

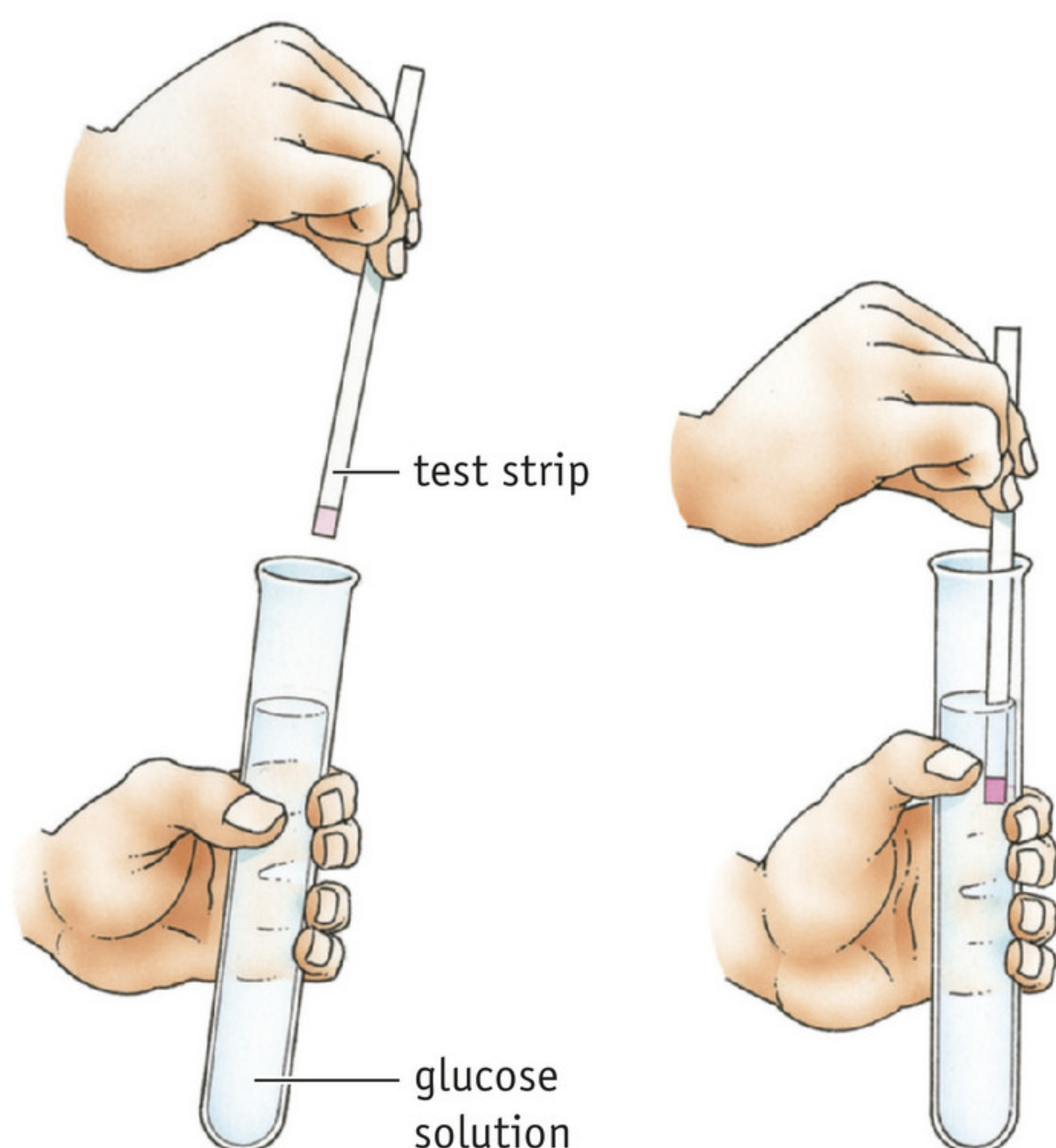
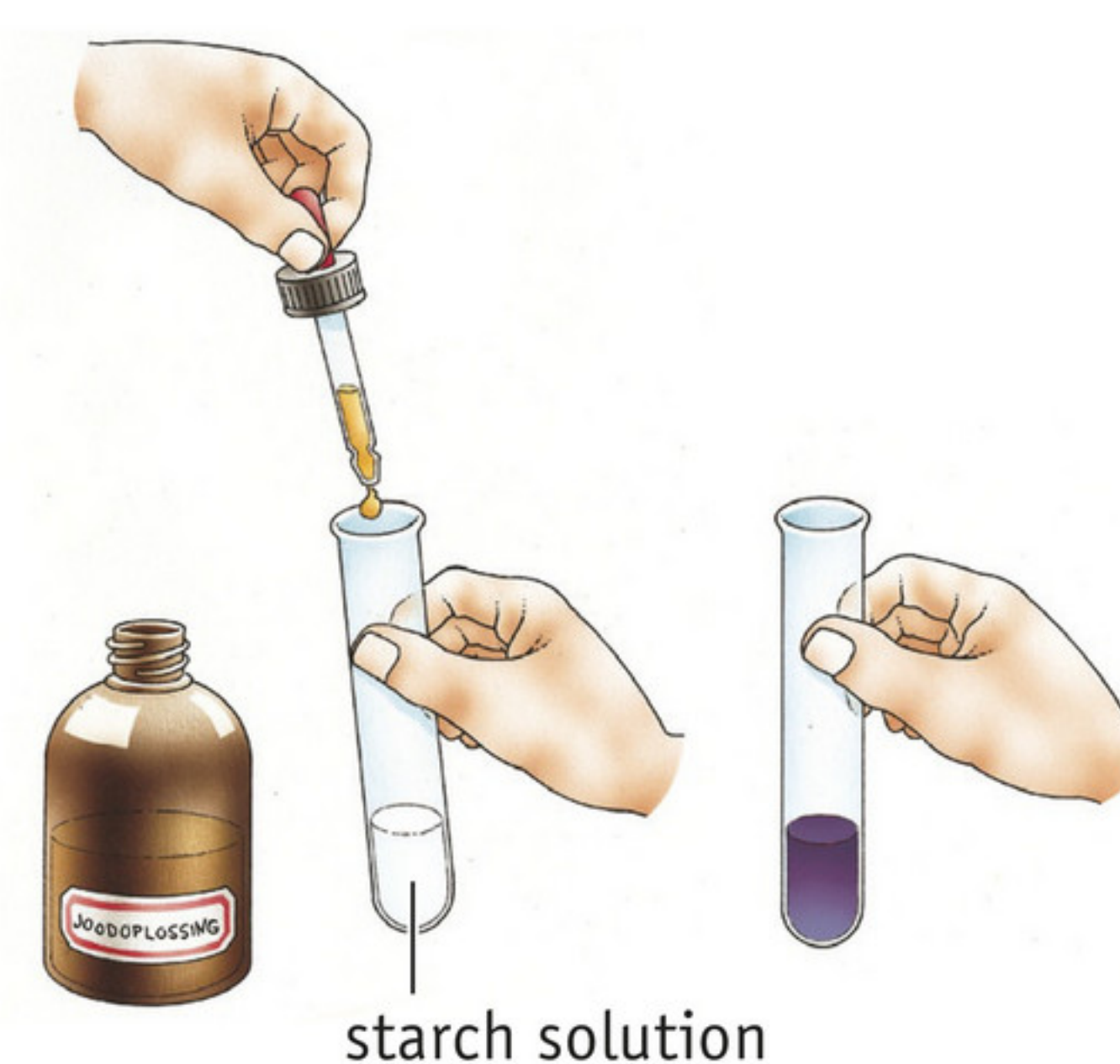


fig. 3 Testing for starch.



EXERCISE**1**

- a** What is an indicator?
- b** Finn is allergic to starch, so he cannot eat or drink foods that contain starch. Josh gives Finn a can of a soft drink, but he is not sure whether the drink contains starch. Finn decides to test it with a test strip from the biology classroom. The strip changes colour, so Finn concludes that he should not drink the can of soft drink. Is Finn right? Explain your answer.

2**THE GOAL OF A STUDY**

► Basics 4 | ► Learning Goal 2.O.17 | ► Practical activity 7

REASONS FOR A STUDY

There are various reasons for researching something. You may perhaps have noticed something about your environment that you want to know more about. For example, you notice that your dog walks in circles around the table. You can then do a literature study on all known dog behaviours. You may also run into a problem that you want to find a solution for. For instance, scientists are doing research into renewable energy. They hope to solve the global climate problem. Simply being interested in a topic can also be a good reason for studying it. Many biology students investigate topics that interest them.

THE GOAL OF A STUDY

If you have a reason to do a study, you then need to express exactly what you want the investigation to achieve. This is the **goal** of your study. Examples of the goal of a study are:

- to explain the behaviour of your dog
- to find solutions for the climate problem
- to find a vaccine against Ebola

The study question is the precisely worded question that you want to find the answer to with your investigation. For example, can the medicine ZMapp make people immune to Ebola? The study question is formulated more precisely than the goal of the research. It is important for scientists to formulate the goal of their research clearly. After all, they have to convince people with money too (such as the government or companies) that their studies are useful to society. This is how they can get the resources to carry out their work.

EXERCISES

1

Read the text ‘Linseed reduces the blood pressure’ in figure 4 and have a look at figure 5, which is the research table that belongs with the study.

- a What was the goal of this research? Write it down in the table.
- b Complete the research table.

fig. 4

Linseed reduces the blood pressure

Canadian researchers have discovered that linseed may help reduce the blood pressure. These seeds from flax plants have a high percentage of omega-3 fatty acids. The researchers studied 110 patients whose blood pressure was too high. Half of them had 30 g of linseed mixed in with their food every day. The control group ate the same, but without the seeds. After six months, the blood pressure had become significantly lower in the linseed group when compared with the control group.

Source: Gezondgids, December 2013.

fig. 5

STUDY	LINSEED AND BLOOD PRESSURE
Goal of the study	
Study question	What effect does linseed have on blood pressure?
Working method	
Results	
Conclusion	

2

Figure 6 shows a study of how children’s leisure-time activities influence the likelihood of them becoming overweight.

- a Write down the goal of the study in the table.
- b Write down the study’s conclusion in the table.
- c What three leisure-time activities reduced the risk of obesity in children?

fig. 6

STUDY	LEISURE-TIME ACTIVITIES AND OBESITY																					
Goal of the study																						
Study question	What effect does the way children spend their leisure time have on whether they become overweight?																					
Working method	The weights of 300 children aged between 4 and 12 are measured. They are also asked whether they belong to a sports club, how much time they spend on the computer/watching TV, and how much time playing outside.																					
Results	computer/TV watching for more than 2 hours a day computer/TV watching for less than 2 hours a day playing outside for less than 0.5 hours a day playing outside for more than 0.5 hours a day not a member of a sports club member of a sports club <table><tr><th>Leisure-time activity</th><th>not a member of a sports club (%)</th><th>member of a sports club (%)</th></tr><tr><td>computer/TV watching for more than 2 hours a day</td><td>16</td><td>11</td></tr><tr><td>computer/TV watching for less than 2 hours a day</td><td>16</td><td>11</td></tr><tr><td>playing outside for less than 0.5 hours a day</td><td>16</td><td>11</td></tr><tr><td>playing outside for more than 0.5 hours a day</td><td>16</td><td>11</td></tr><tr><td>not a member of a sports club</td><td>16</td><td>11</td></tr><tr><td>member of a sports club</td><td>16</td><td>11</td></tr></table>	Leisure-time activity	not a member of a sports club (%)	member of a sports club (%)	computer/TV watching for more than 2 hours a day	16	11	computer/TV watching for less than 2 hours a day	16	11	playing outside for less than 0.5 hours a day	16	11	playing outside for more than 0.5 hours a day	16	11	not a member of a sports club	16	11	member of a sports club	16	11
Leisure-time activity	not a member of a sports club (%)	member of a sports club (%)																				
computer/TV watching for more than 2 hours a day	16	11																				
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playing outside for less than 0.5 hours a day	16	11																				
playing outside for more than 0.5 hours a day	16	11																				
not a member of a sports club	16	11																				
member of a sports club	16	11																				
Conclusion																						

3

The canteen at a school sells sandwiches. The sandwiches are sold in packs of two in a plastic container. Left in that packaging, the bread begins to go mouldy after a couple of days and so it then has to be thrown away. The canteen manager thinks that the sandwiches could be kept for longer if the packaging contained carbon dioxide and nitrogen (instead of air), because bacteria cannot live without oxygen. She is investigating whether this is actually the case.

Fifty sandwiches are packaged the old way, in plastic containers. Fifty more sandwiches are packaged the same way, but the air in the containers is replaced with a mixture of carbon dioxide and nitrogen. Those sandwiches had not yet gone mouldy after seven days. The sandwiches in the containers with normal air went mouldy after seven days. Complete the rest of the table.

fig. 7

STUDY	THE SHELF LIFE OF SANDWICHES		
Goal of the study			
Study question	Do sandwiches keep for longer if they are packed in carbon dioxide and nitrogen instead of air?		
Hypothesis	Yes, because sandwiches spoil because of bacteria, and bacteria need oxygen.		
Working method			
Results		Sandwiches packaged in air	Sandwiches packaged in carbon dioxide and nitrogen
	Mouldy after seven days		
Conclusion			

4

Figure 8 shows the packaging from cartons of whole milk, semi-skimmed milk and skimmed milk. Jules wants to make an informed choice about which he should drink. He decides to investigate this (see figure 9).

- Write down Jules' study goal in the table.
- Draw a bar chart showing the amounts of protein, carbohydrates and fats per 100 mL in whole milk, semi-skimmed milk and skimmed milk.
 - Complete the information for the x-axis and y-axis.
 - Colour in the bar chart using different colours.
 - Complete the key. Colour the squares using the same colours as in the bar chart.
- Write down your conclusion in the table.
- Which milk should Jules drink? Explain your answer.

fig. 8 Labels for three kinds of milk.

Gemiddelde voedingswaarde		
	per 100 ml	per 200 ml
Energie	kJ 262	kJ 524
	kcal 63	kcal 126
Eiwit	3,3 g	6,6 g
Koolhydraten	4,5 g	9,0 g
<i>waarvan suikers</i>	4,5 g	9,0 g
Vet	3,5 g	7,0 g
<i>waarvan verzadigd</i>	2,5 g	5,0 g
<i>enkelv. onverzadigd</i>	0,9 g	1,8 g
<i>meerv. onverzadigd</i>	0,1 g	0,2 g
Voedingsvezels	0,0 g	0,0 g
Natrium	0,04 g	0,08 g
Calcium	118 mg (14,8% ^{**})	236 mg (29% ^{**})

* Gebaseerd op 2000 kcal per dag.
Gemiddelde energiebehoefte:
 - vrouwen 2000 kcal per dag
 - mannen 2500 kcal per dag
^{**} Percentage van de aanbevolen dagelijkse hoeveelheid per portie.

1 whole milk

Gemiddelde voedingswaarde		
	per 100 ml	per 200 ml
Energie	kJ 192	kJ 384
	kcal 46	kcal 92
Eiwit	3,4 g	6,8 g
Koolhydraten	4,6 g	9,2 g
<i>waarvan suikers</i>	4,6 g	9,2 g
Vet	1,5 g	3,0 g
<i>waarvan verzadigd</i>	1,0 g	2,0 g
<i>enkelv. onverzadigd</i>	0,4 g	0,8 g
<i>meerv. onverzadigd</i>	0,0 g	0,0 g
Voedingsvezels	0,0 g	0,0 g
Natrium	0,04 g	0,08 g
Calcium	121 mg (15% ^{**})	242 mg (30% ^{**})

* Gebaseerd op 2000 kcal per dag.
Gemiddelde energiebehoefte:
 - vrouwen 2000 kcal per dag
 - mannen 2500 kcal per dag
^{**} Percentage van de aanbevolen dagelijkse hoeveelheid.

2 semi-skimmed milk

Gemiddelde voedingswaarde		
	per 100 ml	per 200 ml
Energie	kJ 145	kJ 290
	kcal 34	kcal 68
Eiwit	3,6 g	7,2 g
Koolhydraten	4,7 g	9,4 g
<i>waarvan suikers</i>	4,7 g	9,4 g
Vet	0,1 g	0,1 g
<i>waarvan verzadigd</i>	0,0 g	0,1 g
<i>enkelv. onverzadigd</i>	0,0 g	0,0 g
<i>meerv. onverzadigd</i>	0,0 g	0,0 g
Voedingsvezels	0,0 g	0,0 g
Natrium	0,05 g	0,10 g
Calcium	120 mg	30% ^{**}

* Gebaseerd op 2000 kcal per dag.
Gemiddelde energiebehoefte:
 - vrouwen 2000 kcal per dag
 - mannen 2500 kcal per dag
^{**} Percentage van de aanbevolen dagelijkse hoeveelheid per portie.

3 skimmed milk

fig. 9

STUDY	NUTRITIONAL VALUES OF WHOLE, SEMI-SKIMMED AND SKIMMED MILK
Goal of the study	
Study question	What are the differences in nutritional value between whole milk, semi-skimmed milk and skimmed milk?
Working method	The cartons for whole, semi-skimmed and skimmed milk state how many grams of protein, carbohydrates and fat they contain per 100 mL. That data is put in a bar chart.
Results	↑ 7 6 5 4 3 2 1 0 whole milk semi-skimmed milk skimmed milk Key:
Conclusion	

Practical activities

1

TESTING FOR GLUCOSE

► Basics 1 | ► Learning objective 2.O.15 | ► Learning how to do research 1

 10-20 minutes

WHAT ARE YOU GOING TO DO?

In this practical activity, you will learn how to test for glucose.

WHAT DO YOU NEED?

- ☐ 2 test tubes in a test tube rack (see figure 1)
- ☐ 2 labels
- ☐ a knife
- ☐ glucose
- ☐ –2 test strips to test for glucose (e.g. Clinistix)

WORKING METHOD

- Stick a label onto each test tube.
- Number the test tubes 1 and 2.
- Add three pinches of glucose to test tube 1. Add water until the test tube is roughly three-quarters full. Shake the test tube thoroughly.
- Dip the end of a test strip in the glucose solution. Remove the test strip from the test tube and shake off the liquid.
- Compare this test against the test strip that you haven't yet used. Write down whether there was a colour change and if so, how the colour changed.
- Fill test tube 2 roughly three-quarters full with water. Dip the end of the second test strip in the water. Remove the test strip from the test tube and shake off the liquid.
- Write down whether there was a colour change and if so, how the colour changed.

fig. 1 What do you need?



EXERCISE

1

- a How does the colour change if you dip a test strip in a solution containing glucose?
- b Do you also get that change in colour if you dip a test strip in water? *yes / no*
- c Why did you investigate whether the colour also changes in water?

2 TESTING FOR STARCH

► Basics 1 | ► Learning objective 2.O.16 | ► Learning how to do research 1

 10-20 minutes

WHAT ARE YOU GOING TO DO?

In this practical activity, you will learn how to test for starch.

WHAT DO YOU NEED?

- ☐ 2 test tubes in a test tube rack (see figure 2)
- ☐ 2 labels
- ☐ a knife
- ☐ starch
- ☐ iodine solution in a bottle with a pipette

fig. 2 What do you need?



WORKING METHOD

- Stick a label onto each test tube.
- Number the test tubes 1 and 2.
- Put a pinch of starch in test tube 1 (see figure 3). Add water up to about 3 cm. Shake the test tube.
- Pour water only into test tube 2, again up to about 3 cm.
- Write down in the table what the colour of the liquid in each test tube was (initial colour).
- Then add five drops of iodine solution to each of the two test tubes. Shake the test tubes.
- Write down in the table what the colour of the liquid in each test tube was (colour with iodine solution).

	Initial colour	Colour with iodine solution
Test tube 1 (starch and water)		
Test tube 2 (water)		

fig. 3



EXERCISE

1

- a What indicator did you use to test for starch?
- b What colour do you get when you mix starch with iodine solution?

3 GLUCOSE AND STARCH IN FOODS

► Basics 1 | ► Learning objectives 2.O.15 and 2.O.16 | ► Learning how to do research 1

 40-50 minutes

WHAT ARE YOU GOING TO DO?

In this practical activity, you are going to study glucose and starch in food.

WHAT DO YOU NEED?

The things you need are given in the table.

WORKING METHOD

Do the experiment and complete the rest of the table.

This is a descriptive study, so you do not need to think of a hypothesis.

STUDY	GLUCOSE AND STARCH IN FOODS
Study question	Which food products contain starch and which contain glucose?
What do you need?	☐ food products, for example potato, bread, cola, cheese, milk, orange juice, onion (see figure 4) ☐ a knife and a dish (for cutting up the solid foods) ☐ 2 test tubes in a test tube rack ☐ labels ☐ test strips to test for glucose (as many as there are different food products) ☐ iodine solution in a bottle with a pipette  fig. 4 What do you need?
Working method	• Stick labels onto the test tubes and number them 1 and 2. • Take a food product. • If it is a liquid food product, pour it directly into the test tube. If it is a solid food product, chop it up into very small pieces first (see figure 5). • Add three pinches of the finely chopped food product to test tube 1. Add water until the test tube is roughly three-quarters full. Shake the test tube thoroughly. Pour liquid food products directly into the test tube until the test tube is roughly three-quarters full. • Put a good pinch of the finely chopped food into test tube 2. Add water up to about 3 cm. Shake the test tube thoroughly. Pour liquid food products directly into the test tube up to about 3 cm. • Dip the end of a test strip in the liquid in test tube 1. Remove the test strip from the test tube and shake off the liquid. • Add five drops of iodine solution to test tube 2. Shake the test tube thoroughly. • Write down which food product you are investigating in the left-hand column of the table in the 'Results' section. Write down whether the test strip changes colour in the middle column. Write down whether you get a bluish-black colour with iodine solution in the right-hand column. • Clean the test tubes thoroughly. Your teacher will tell you what you should do with the contents of the test tubes. • Use the same procedure to investigate whether the other food products contain glucose and/or starch. Write down your data in the 'Results' section. • Clean the test tubes thoroughly between each test. fig. 5 

Results	Food	Test strip changes colour?	Bluish-black colour with iodine solution?
Conclusion			
Discussion	Did everything go according to the work plan? Did you fill each tube as specified in the work plan, for instance? How reliable are your results? Did the food products stay properly separated, for instance?		

4 THE EFFECT OF SALIVA ON STARCH

► Basics 2 | ► Learning objective 2.2.3

 40-50 minutes

WHAT ARE YOU GOING TO DO?

In this practical activity, you will be investigating what effect saliva has on a starch solution.

This is a descriptive study, so you do not need to think of a hypothesis.

WHAT DO YOU NEED?

The things you need are given in the table.

WORKING METHOD

Do the experiment and complete the rest of the table.

STUDY	THE EFFECT OF SALIVA ON STARCH							
Study question	What effect does saliva have on a starch solution?							
What do you need?	☐ 4 test tubes in a test tube rack ☐ 4 labels ☐ 2% starch solution ☐ a water bath with water at about 37 °C ☐ iodine solution in a bottle with a pipette							
Working method	• Stick a label on each test tube. Number the test tubes 1 to 4. • Collect some saliva in your mouth. Fill test tube 1 to about 1.5 cm with saliva. Thin, watery saliva gives a better result than thick, mucous saliva. • Fill test tube 2 with the same amount of water as the saliva in test tube 1. • Fill test tubes 3 and 4 to about 1.5 cm with starch solution. Make sure that the quantities in the tubes are the same. • Add the contents of test tube 3 to test tube 1 and test tube 4 to test tube 2. Shake the test tubes well. • Place test tubes 1 and 2 in the water bath at 37 °C. Leave the tubes for about 25 minutes. • Then add five drops of iodine solution to each of the two test tubes. Shake the test tubes well.							
Results	<table><tr><th>Tube</th><th>Colour with iodine solution</th></tr><tr><td>1 starch solution with saliva</td><td></td></tr><tr><td>2 starch solution with water</td><td></td></tr></table>		Tube	Colour with iodine solution	1 starch solution with saliva		2 starch solution with water	
Tube	Colour with iodine solution							
1 starch solution with saliva								
2 starch solution with water								
Conclusion								
Discussion	Did everything go according to the work plan? Were all the test tubes filled according to the work plan? Was your saliva thin and watery, or thick and slimy? How reliable are your results? Were there residues of food in your saliva, for instance?							

5

YOUR OWN TEETH

► Basics 2 | ► Learning objective 2.2.4



 15-25 minutes

WHAT ARE YOU GOING TO DO?

Figure 7 shows you the upper jaw and lower jaw with a full permanent set of teeth, as you would see them in the mirror. In this practical activity, you will be studying your own teeth and noting the results.

WHAT DO YOU NEED?

- ☐ a mirror
- ☐ a small mirror such as a dentist's mirror (see figure 6)

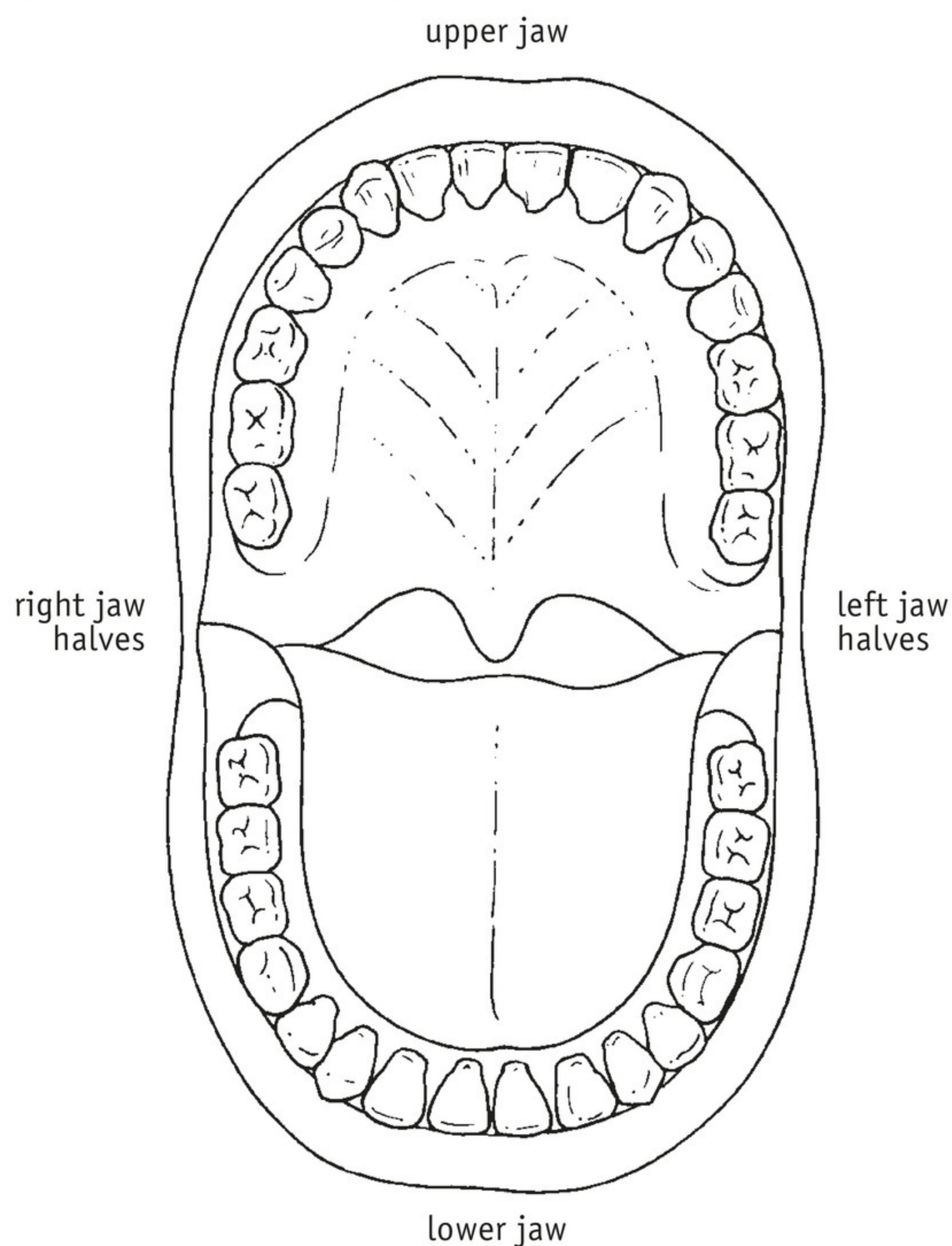
WORKING METHOD

- Examine your own teeth. You can see the teeth in your lower jaw directly in the mirror. You need the little mirror too to see the teeth in your upper jaw.
- Draw a cross in figure 7 through any teeth that you no longer have or that have not appeared yet (for example your wisdom teeth).
- If you have teeth with a filling, colour the place where the filling is black. Do this as accurately as possible. Colour any artificial parts red (for example, a crown or a bridge).

fig. 6 A dentist's mirror.



fig. 7 Upper jaw and lower jaw.



6

THE LOCATIONS OF THE ORGANS

► Basics 3 | ► Learning objective 2.3.6

 15-20 minutes

WHAT ARE YOU GOING TO DO?

In this demonstration practical activity, your teacher will show you a model torso with the organs of the digestive system. Your teacher will remove some of the organs from the torso one by one.

WHAT DO YOU NEED?

☐ coloured pencils

EXERCISE

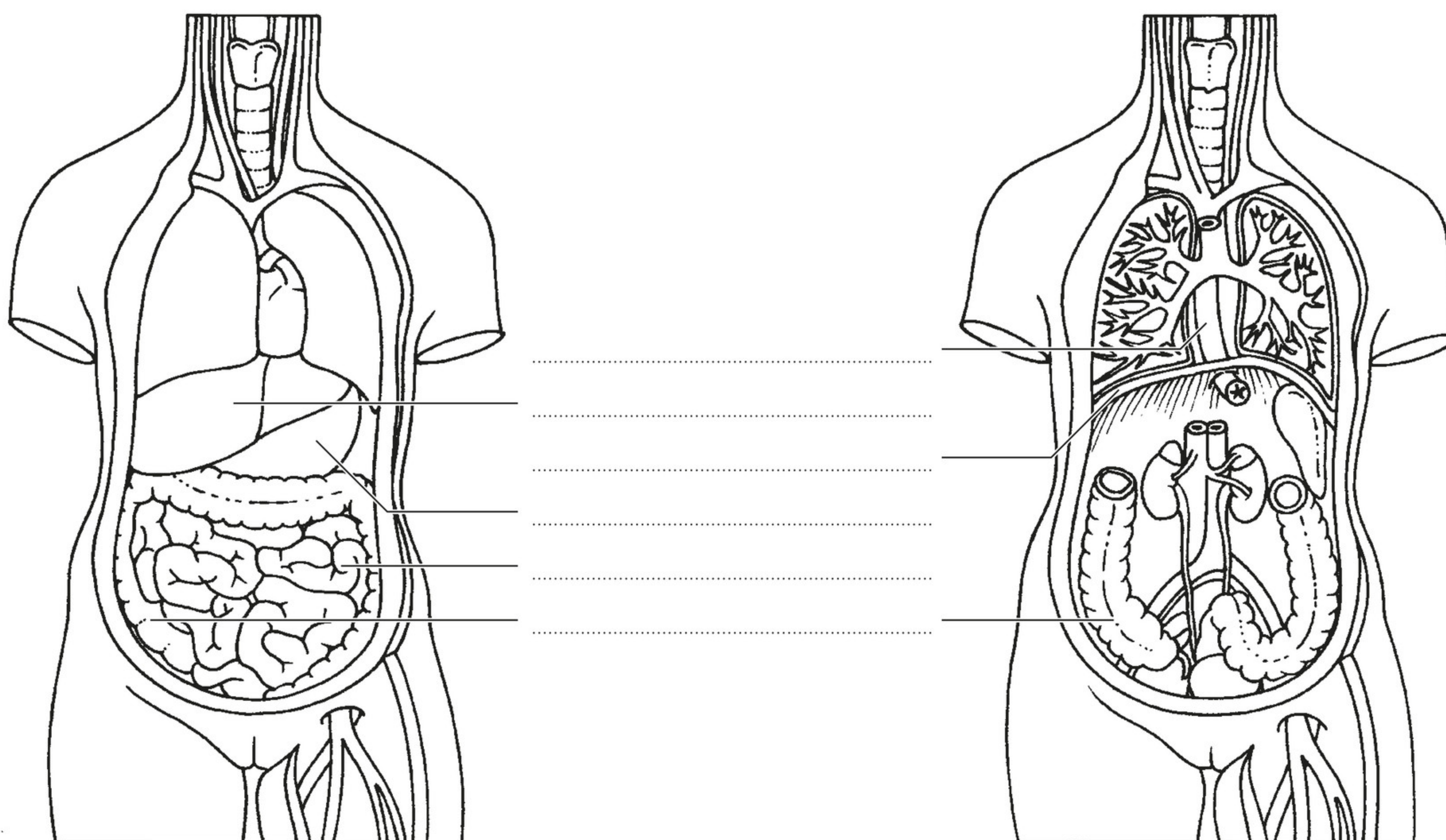
1

Figure 8 shows two schematic drawings of the torso of a woman.



- a Write down the names of the organs the lines point to.
- b Colour in the organs in the drawing. Use a different colour for each organ.

fig. 8



7

HOW HEALTHY IS THE SCHOOL CANTEEN?

► Basics 4 | ► Learning objectives 2.4.8 and 2.O.17 | ► Learning how to do research 2

 **Lesson 1: 10-15 minutes, lesson 2: 15-20 minutes**

WHAT ARE YOU GOING TO DO?

Most canteens include products and product groups that are not on the Wheel of Five. On top of that, many canteens do not always look very healthy. In this practical activity, you will be investigating how healthy your school canteen is.

Do this practical activity together with a classmate.

WHAT DO YOU NEED?

The things you need are given in the table.

WORKING METHOD

- Read the study thoroughly beforehand.
- Prepare your study in lesson 1.
 - Write down the study goal in the table.
 - Install the ‘Kies Ik Gezond?’ (‘Am I Choosing Healthily?’) app.
 - Make the table and checklist.
- Carry out the study in between the two lessons.
- Process the results in lesson 2 and complete the rest of the table.

STUDY	A HEALTHY CANTEEN
Goal of the study	
Study question	How healthy is the school canteen?
What do you need?	☐ the ‘Kies Ik Gezond?’ (‘Am I Choosing Healthily?’) app (see www.voedingscentrum.nl/kiesikgezond) from the Netherlands Nutrition Centre (see figure 9) ☐ the nine points for a healthy canteen appearance as listed by the Netherlands Nutrition Centre (see gezondeschoolkantine.voedingscentrum.nl/uitstraling)

fig. 9 The ‘Kies Ik Gezond?’ (‘Am I Choosing Healthily?’) app.



Working method	• Make a table with two columns. Above the first column, write <i>On the Wheel of Five</i>. At the top of the second column, write <i>Not on the Wheel of Five</i>. • Make a checklist with the nine points saying what a healthy canteen should look like. Divide the points for its appearance into two headings, <i>Basic points</i> and <i>Additional points</i>. • Go to the school canteen when it is open. Write down all the products for sale in your school canteen in the correct columns in the table. You can use the ‘Kies Ik Gezond?’ (‘Am I Choosing Healthily?’) app to look up which column a product should be put in. (If you cannot use the app at school, just write down the products and put them in the correct columns in the table later.) • Use the checklist to find out which points your canteen complies with. Don’t forget the vending machines.
Results	• Make bar chart of the table. • Put the results of the checklist under the bar chart. For example, make a table showing how many basic points and how many additional points the canteen complies with.
Conclusion	
Discussion	Did everything go according to the work plan? Were you able to find all the products in the school canteen, for instance, or were some food products not available then? How reliable are your results? Was the selection the same as always, or was there a special offer?

EXERCISE

1

- a Is there enough choice for pupils who want to eat according to the Wheel of Five? Explain your answer.
- b Write down at least five products from the Wheel of Five that you would like to add to the canteen’s selection. Explain why you want to add each product.
- c Note down at least five products that you think could be removed from the range available. Explain for each product why you think it could be removed.
- d Make a suggestion about how the appearance of the school canteen could be made healthier. Explain your answer.

8

TASTY AND HEALTHY

► Basics 4 | ► Learning objective 2.4.8

 **Lesson 1: 20-30 minutes, lesson 2: 40-50 minutes**

WHAT ARE YOU GOING TO DO?

In this practical activity, you will think of a recipe for a sandwich that is not only tasty but also fits with the Wheel of Five. You will present this recipe to the class.

Do this practical activity together with a classmate.

WHAT DO YOU NEED?

Think of everything you need yourself.

WORKING METHOD

- Think of a recipe for a sandwich in lesson 1. All the ingredients must be on the Wheel of Five (including the bread).
- Write down all the ingredients on a shopping list. Describe the ingredients accurately (for example cheese with less salt or sugar-free ketchup). Write your group number or group name on the list.
- Hand the shopping list in to your teacher. Your teacher will arrange the ingredients for the second lesson.
- Make the sandwich during lesson 2 using the ingredients from your shopping list. Cut your sandwich into bite-sized pieces. If you can, make as many pieces as there are pupils in your class.
- Present your sandwich to the class. Convince the class why your sandwich is the tastiest and healthiest.
- After all presentations are done, vote individually for the sandwich you thought was the tastiest and healthiest. You can perhaps taste the sandwiches you like best before making your choice.

EXERCISE

1

- a Which sandwich was chosen by the class as the tastiest and healthiest? Write down the recipe.
- b Which sandwich did you think was the tastiest and healthiest? Write down the recipe. If it is the same sandwich as the one that was picked by the class as the best, write down the recipe of the sandwich you thought was second best.

9

THE TEETH OF AN ANIMAL

► Basics 6 | ► Learning objective 2.6.12

 15-25 minutes

WHAT ARE YOU GOING TO DO?

In this practical activity, you will look at and draw the teeth of an animal.

WHAT DO YOU NEED?

- ☐ an animal skull with teeth
- ☐ drawing materials

WORKING METHOD

- Lay the skull in front of you so that you can see all the teeth in the right-hand jaw halves (see figure 10).
- Make a true-to-life drawing of the teeth in the right-hand jaw halves. You only have to draw the jaws (schematically) and you can leave out the rest of the skull.
- Mark the various teeth: *canine* – *cutting molar* / *molar with knobbly surfaces* / *ridged molar* (pick one of these three) – *incisor*.
- Add a label below the drawing saying what species of animal it came from.

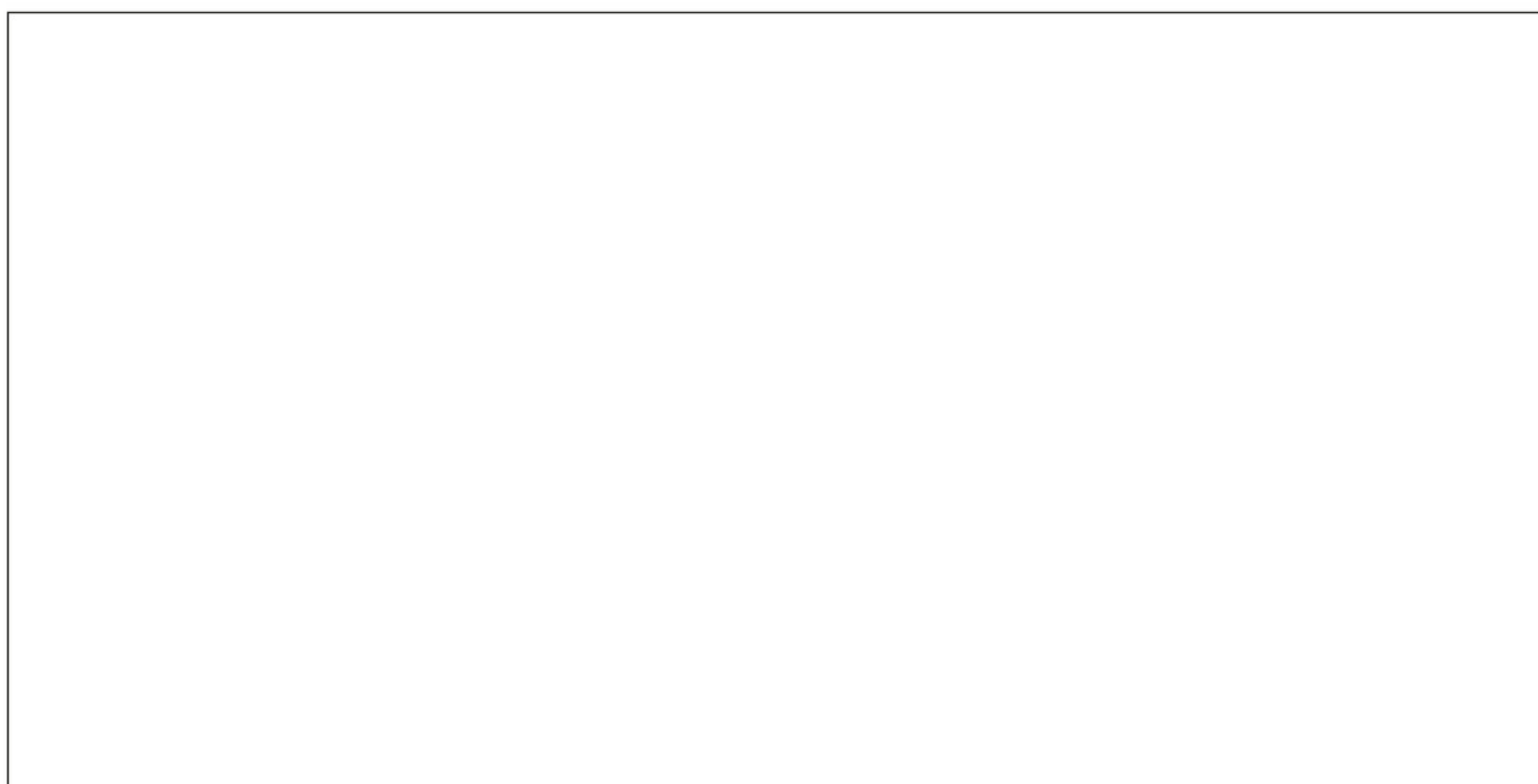


fig. 10 Animal skulls.



1 a squirrel



2 a rabbit



3 a field mouse

Summary

BASICS 1

FOOD PRODUCTS AND NUTRIENTS

1 You can state the functions of nutrients and dietary fibre in foods.

- Foods: all the products that you eat or drink.
 - Vegetable foodstuffs: the roots, stems, leaves, fruits or seeds of various plants.
 - Animal-based foodstuffs: parts of animals (meat or fish) or products from animals (eggs and dairy produce, e.g. milk, butter, cheese and yoghurt).
- Nutrients: the usable components of foodstuffs.
 - Building blocks: used in making cells and tissues (particularly for growth, development and recovery in the body).
 - Fuels: provide the energy needed for movement and to keep your body temperature up and for growth, development and repairs to your body.
 - Food reserves: are stored in certain parts of the body.
 - Protective substances that make sure that you stay healthy.
- Dietary fibre: all the indigestible parts of plant-derived food.

2 You can name six groups of nutrients and list their functions.

- Proteins:
 - Functions: primarily as building blocks, also as fuel.
 - Excess proteins are converted into fat and stored as food reserves.
- Carbohydrates:
 - Functions: primarily as fuel, also as building blocks and reserves.
 - Sugars (such as glucose), starch and glycogen are examples of carbohydrates.
 - Excess carbohydrates are converted to fat and stored as food reserves.
 - Glucose can be converted into glycogen and stored in the liver and the muscles.
- Fats:
 - Functions: primarily as fuel, also as building blocks and reserves.
 - Fats can also be stored as food reserves under the skin.
- Water:
 - function: building materials.
 - Water is important for instance in transporting substances around the body.
- Minerals (salts):
 - function: building materials and protective substances.
 - Example: calcium phosphate for building bones.
- Vitamins:
 - function: building materials and protective substances.
 - Vitamins are identified by letters (for example A, B, C, D and K).
 - Examples: vitamin A for producing skin and seeing well; vitamin D for fixing calcium phosphate in the bones.

BASICS 2

THE DIGESTIVE SYSTEM

3 You can describe the functions of digestion, digestive juices and enzymes.

- Digestion: the conversion of nutrients that cannot pass through the wall of the gut into the blood into digestion products that can be absorbed into the bloodstream.
 - Proteins, most carbohydrates (including sugars and starches) and fats are digested.
 - Glucose, minerals, vitamins and water do not need to be digested.
- Mechanical digestion: to break the food up into small pieces by chewing.
- Chemical digestion: to convert nutrients using digestive juices.
 - Digestive juices are made by the digestive glands.
 - Many digestive juices contain enzymes.
- Enzymes: substances that catalyse the chemical processes.
 - The enzymes in digestive juices make sure that digestion proceeds quickly.

4 You can list the parts of your dentition and their functions.

- Incisors and canines are for biting pieces off the food.
 - Canines are somewhat more pointed than incisors.
- Molars are for grinding the food up finely.
 - Molars have a knobbly top surface.
- Functions of the teeth: to break the food up into small pieces (chewing).
 - Makes the food easier to swallow.
 - It increases the surface area of the food so that enzymes have more surface area to work on.

5 You can describe the function of peristalsis and how it works.

- Peristalsis (peristaltic movements): alternate contraction and relaxation of the circular muscles and longitudinal muscles in the wall of the entire intestinal tract.
- Functions: to move the food pulp along, kneading and mixing it with digestive juices.
- Dietary fibre: needed for good peristalsis.

BASICS 3

THE DIGESTIVE ORGANS

6 You can list the functions and characteristics of the parts of the digestive system.

- Oral cavity (mouth) with salivary glands:
 - Function of salivary glands: to produce saliva.
- Oesophagus (gullet):
 - Function: to move the food from the pharynx (throat) to the stomach.
- Stomach:
 - Function: temporary storage of the food.
 - Pyloric sphincter: a circular muscle that closes off the stomach.
 - The gastric glands produce gastric juice.
- Liver:
 - Function: to produce bile.
 - Bile is stored temporarily in the gall bladder and secreted from there via the bile duct.
- Pancreas:
 - Function: to produce pancreatic juice.
- Duodenum:
 - Function: to mix the bile and pancreatic juices with the chyme (food pulp).
- Small intestine:
 - Function: to absorb nutrients, digestion products and water into the blood.
 - The wall has intestinal folds and villi, giving it a large surface area. The intestinal villi contain numerous blood vessels.
 - The intestinal glands produce intestinal juice.

- Caecum with vermiform appendix:
 - In appendicitis, the vermiform appendix is inflamed (although the Dutch word confusingly suggests the caecum is inflamed).
- Large intestine:
 - Function: to remove water from the pulp of undigested food residues, which thereby becomes thicker. The water is absorbed into the bloodstream.
 - Diarrhoea is when not enough water is being absorbed into the blood from the small intestine and large intestine.
 - Bacteria digest cellulose from the cell walls of plant-based food residues. This produces glucose, which is partly absorbed into the bloodstream.
- Rectum:
 - Function: to collect and provide temporary storage for undigested food residues (faeces).
 - Anus: sphincter that closes off the rectum.

7 You can list the digestive juices and their functions.

- Saliva: water, mucus and an enzyme.
 - Function of mucus: to help lubricate the food.
 - Function of the enzyme: partial digestion of starch.
- Gastric juice: water, hydrochloric acid and an enzyme.
 - Function of hydrochloric acid: to kill bacteria in the food.
 - Function of the enzyme: partial digestion of proteins.
- Bile: contains an enzyme.
 - Function: emulsification of fats (break large drops up into small droplets), so that the enzymes can get at the fats better.
- Pancreatic juice: contains various enzymes.
 - Function: digestion of proteins, carbohydrates and fats.
- Gastric juice: contains various enzymes.
 - Function: to complete the digestion of proteins and carbohydrates.

BASICS 4

HEALTHY FOOD

8 You can use the Wheel of Five to give advice about a healthy diet.

- Eat a varied diet: eat things from each of the sections of the Wheel of Five every day.
 - Eat plenty of vegetables and fruit.
 - Eat soft and liquid fats.
 - Eat more plant-based and less meat-based food.
 - Eat mainly wholemeal products.
 - Drink thirst quenchers without sugar.

Section	Food products	The food products contain:
Green	fruit and vegetables	vitamin C and dietary fibre
Yellow	margarine, light margarine or oils	fats and vitamins
Pink	milk, cheese (or other dairy produce) and meat, meat products, chicken, fish, egg or meat substitutes	protein, minerals and vitamins
Orange	bread and potatoes (or rice, macaroni, spaghetti, pulses, couscous)	protein, minerals, vitamin, dietary fibre and starch
Blue	drinks	water

9 You know what a healthy weight is and what choices can help maintain it.

- Body mass index (BMI) = $\frac{\text{weight}}{\text{height} \times \text{height}}$ with the weight in kg and the height in m.
 - Boys aged 12 to 14: a healthy weight if their BMI is about 15 to 23.
 - Girls aged 12 to 14: a healthy weight if their BMI is about 16 to 23.
 - Adults: a healthy weight if their BMI is about 20 to 25.
- Having fat in and around the abdomen in particular is bad for your health.
- Overweight: you are heavier than you should be for your age and height.
 - Consequences of overweight: a higher risk of developing cardiovascular diseases, type 2 diabetes and joint problems.
- Underweight: you are lighter than you should be for your age and height.
 - Consequences of being underweight: more likely to get sick, feeling tired or lethargic.
- Choices for a healthy weight:
 - Eat healthily, according to the Wheel of Five.
 - Don't eat too little and don't skip meals.
 - Don't eat too much and don't eat unhealthy food.

10 You can name the possible causes and consequences of eating disorders and give a few examples.

- Causes of eating disorders:
 - influences from your culture or the media
 - bad events in your life
 - wanting to feel in control
 - fear of failure or perfectionism
 - being dissatisfied with yourself or your outward appearance
- Anorexia nervosa: starving yourself from fear of gaining weight.
- Bulimia nervosa: bouts of overeating with vomiting or use of laxatives.
- Binge eating disorder: bouts of overeating but without vomiting or laxatives.
- Eating disorders can cause:
 - malnourishment (anorexia, bulimia) and the resulting diseases, hair loss, etc.
 - damage to the oesophagus due to vomiting
 - being severely overweight (obese) in the case of binge eating disorder

BASICS 5

FOOD SPOILAGE**11 You can list ways of preventing food spoilage.**

- Food poisoning: an immune reaction caused by eating food that has been contaminated with toxins.
- Preserving: treating food so that it does not spoil.
 - Preserving food makes the conditions unfavourable for bacteria and fungi.
- Freezing (e.g. meat): taking the temperature down to -20°C (or lower).
 - Bacteria and moulds cannot reproduce at these temperatures.
- Pasteurization (e.g. milk): heating to a temperature of 72°C at which most bacteria and moulds are killed. Pasteurized milk should be kept in the refrigerator.
- Sterilization (e.g. milk): heating to a temperature of $130\text{--}140^{\circ}\text{C}$ at which all bacteria and moulds are killed.
 - Many foods (e.g. vegetables) are sterilized and then canned (airtight packaging).
- Vacuum packing: all the air is sucked out of the packaging (e.g. coffee is vacuum packed after roasting).
- Inert atmosphere: under the correct mixture of gases, foodstuffs can be kept longer, as well as keeping their colour for longer (e.g. meat).
- Drying (e.g. milk powder and raisins): removing the water from the food.

- Irradiation (e.g. chicken): using gamma rays (from a radioactive source) so that bacteria and fungi will be killed or only able to reproduce less quickly.
- Adding natural preservatives: bacteria and fungi cannot handle too much sugar, acid, salt, or nitrogen.
 - A lot of sugar is added to jam.
 - A lot of salt is added to fresh herrings and olives.
- Adding artificial preservatives: e.g. sulphite in drinks.
- Additives: substances that are added to foodstuffs so that they will keep for longer or are more attractive in some way (e.g. preservatives, aromas, colourings and flavourings).

BASICS 6

NUTRITION AND DIGESTION IN MAMMALS

12 You can state the relationship in mammals between the choice of diet, the length of the intestinal tract and features of their teeth.

- Plant-based food is harder to digest than animal-based food because the plant-based food contains cell walls made of cellulose.
- Herbivores:
 - The intestinal tract is relatively long in comparison to the body length.
 - The molars are ridged to help them grind the plant-based food up small. The ridges are perpendicular to the direction of the chewing motion.
 - There are often no canines.
- Carnivores:
 - The intestinal tract is relatively short in comparison to the body length.
 - The molars are for shearing and cutting the animal food into pieces. The upper jaw is wider than the lower jaw.
 - The canines are mostly large, pointed and sharp.
- Omnivores:
 - The intestinal tract is medium length in comparison to the body.
 - The molars have bumpy, knobbly surfaces that help both cut and grind the food.
 - Omnivores generally do have canines.

EXTRA 7

THINKING ABOUT FOOD

13 You can explain why eating less meat is good for your health and for the environment.

- Reasons for eating less meat:
 - respect for animals
 - taking care of your health
 - religious beliefs
 - caring for the environment
 - the global food situation
 - the price
- Eating less meat is better for your health.
 - Replacing meat with pulses and nuts reduces the risk of chronic diseases.
- Eating less meat is good for the environment.
 - lower greenhouse gas emissions
 - less water needed to produce food
- Vegetarians do not eat meat and sometimes no fish either.
- Vegans do not use or consume any animal-based products at all, including milk, eggs and cheese.

- Flexitarians eat meat every now and then, but not every day.
- Products that can replace the meat in the meal include pulses, tofu, cheese, eggs and meat substitutes.
- Meat substitutes must contain extra amounts of:
 - iron, because the body is less able to absorb iron from plant-based foods;
 - vitamin B12, because there is little or none of that in plant-based foods.

EXTRA 8

PRODUCT INFORMATION

14 You can explain the information on food product packaging.

- Product information: food packaging gives information about what it contains.
 - the product name
 - the name of the manufacturer
 - the net volume
 - the ‘best before’ date
 - the ingredients
- Best before ...: on products that do not spoil very quickly.
 - The quality may deteriorate after the ‘best before’ date.
 - You can usually still safely eat the product.
- Use by ...: on highly perishable products.
 - The ‘use by’ date is the last day on which you can safely eat the product.
 - You should throw products away after the ‘use by’ date.
- The storage instructions tell you how to store the product.
- The ingredients are the raw materials that the product is made from.
 - Ingredients are listed in sequence of decreasing quantity in the product.
 - It also states the additives or other excipients added.
 - Additives with E numbers don’t affect your health.
- Nutritional value:
 - How much energy, fat, protein, carbohydrate and salt is in the product (per 100 g or per 100 mL).
 - The amount of energy is usually quoted in both kilojoules (kJ) and kilocalories (kcal).

RESEARCH

LEARNING HOW TO DO RESEARCH & PRACTICAL ACTIVITIES

15 You can test for glucose with an indicator.**16 You can test for starch with an indicator.****17 You can formulate the research goal (with help).**

 Go to the *Flash cards* and the *Diagnostic test*.

3

The circulatory system

Blood flows around your body through blood vessels. Blood transports all kinds of substances, including oxygen and nutrients. White blood cells destroy germs. The kidneys clean your blood.

BASICS

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RESEARCH

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TO FINISH

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1 Blood

LEARNING OBJECTIVE

3.1.1 You can name the components of blood with their features and functions.

- Learning how to do research 1 and 2
- Practical activity 1

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES		
	3.1.1	2.3.7**	2.5.11**
Remembering	1, 2a, 3a, 4ab		
Understanding	2b, 3bcde, 4c, 5, 10c		
Using	6ab, 7a, 8ac, 10ab		
Analysing	6c, 7b, 8b, 9	10d	10d

** You can find this learning objective in another unit.

An adult human has five to six litres of blood in their body. Blood carries oxygen and carbon dioxide throughout your body, as well as many other substances. This is what biologists call ‘transport’.

THE COMPOSITION OF BLOOD

A liquid called **blood plasma** makes up 55% of the blood’s volume. The rest of the blood (45%) is made up of **red blood cells**, **white blood cells** (see figure 1) and **platelets**. Figure 2 shows two test tubes with blood. Tube 1 contains fresh blood. In tube 2, the blood has been separated into blood cells and platelets (at the bottom) and blood plasma, which is yellow in colour.

The function of blood is transporting everything needed for the body to function, such as food, oxygen and heat. The blood also carries away carbon dioxide and other waste products.

fig. 1 Blood cells (3600× magnification).

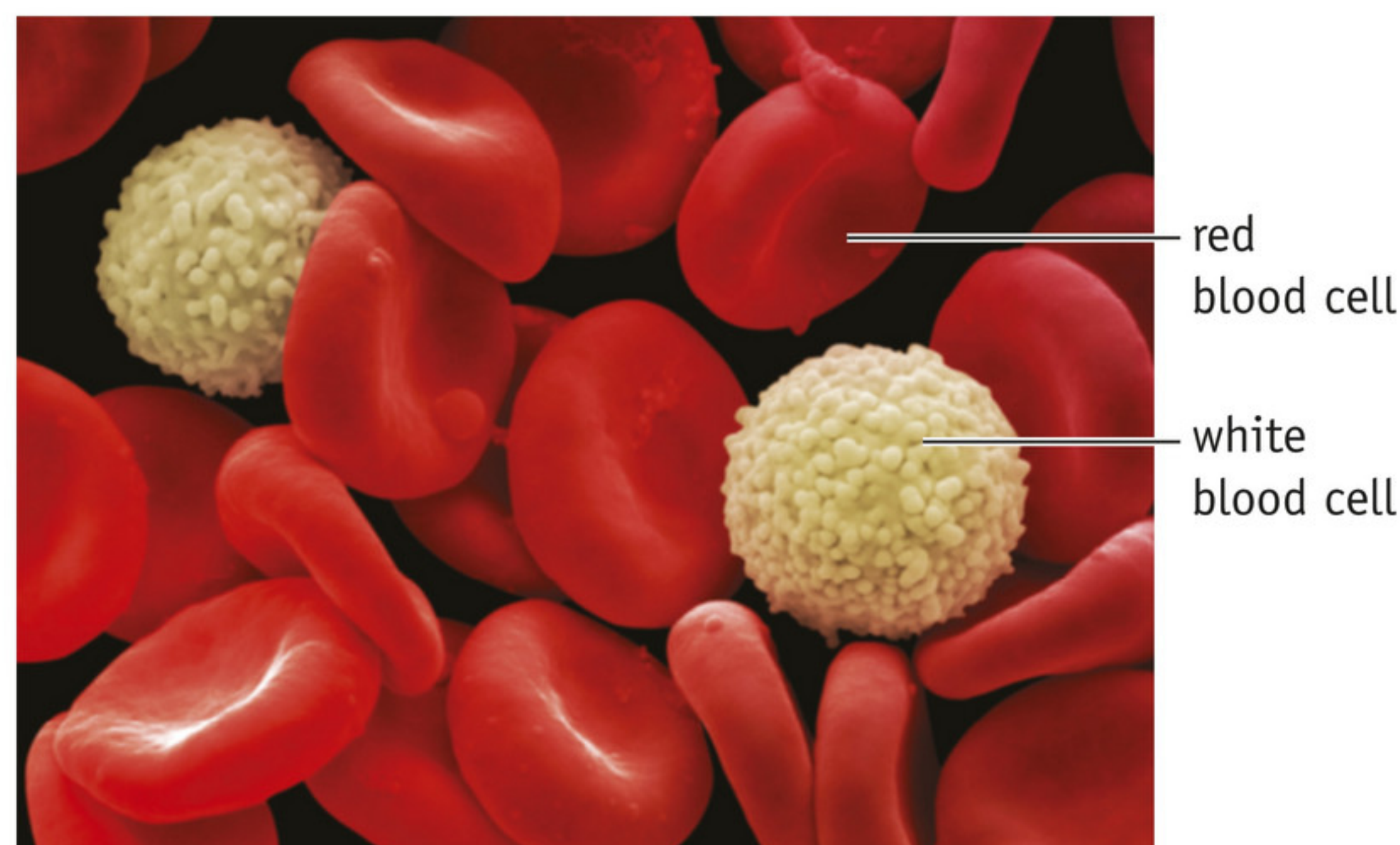
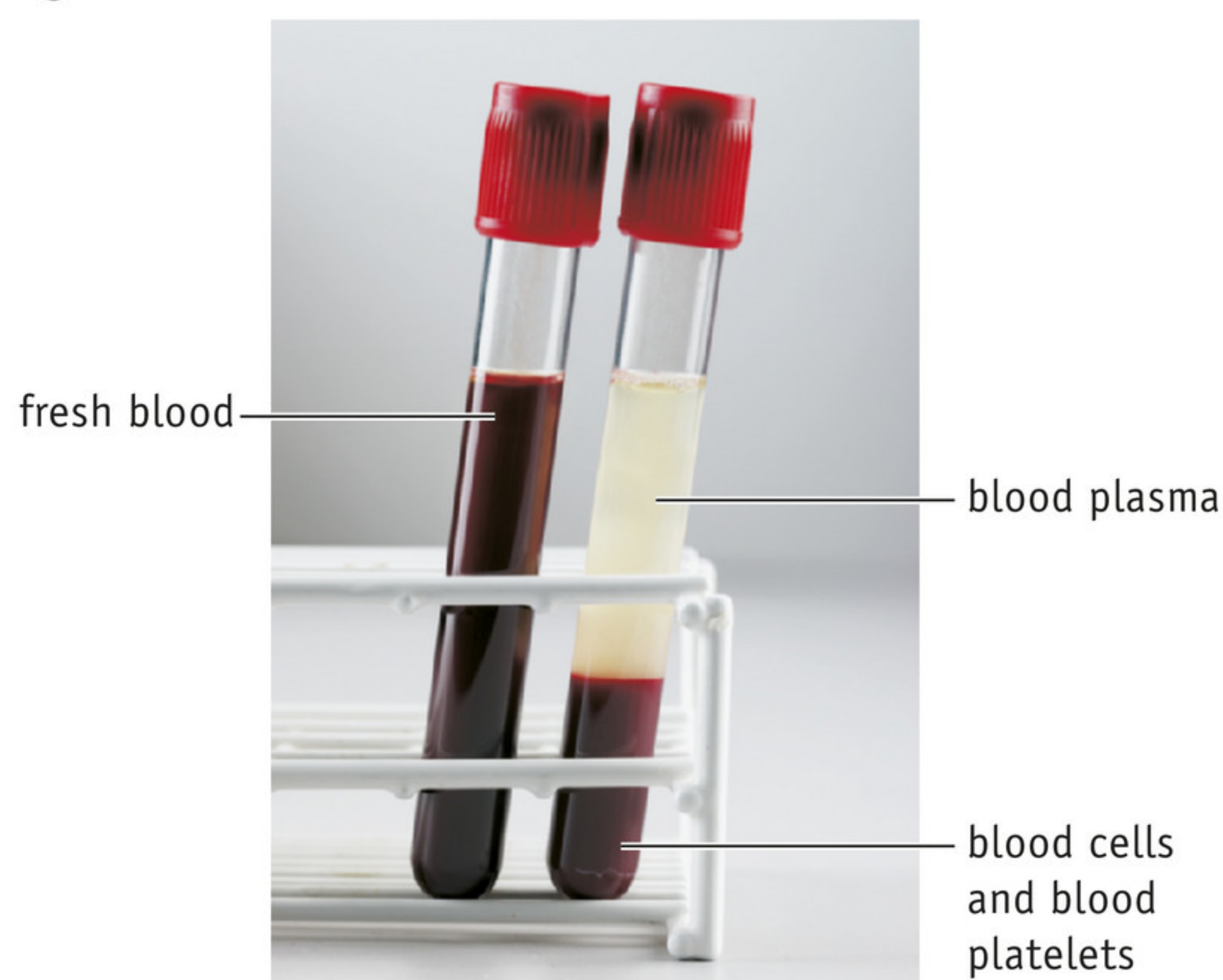


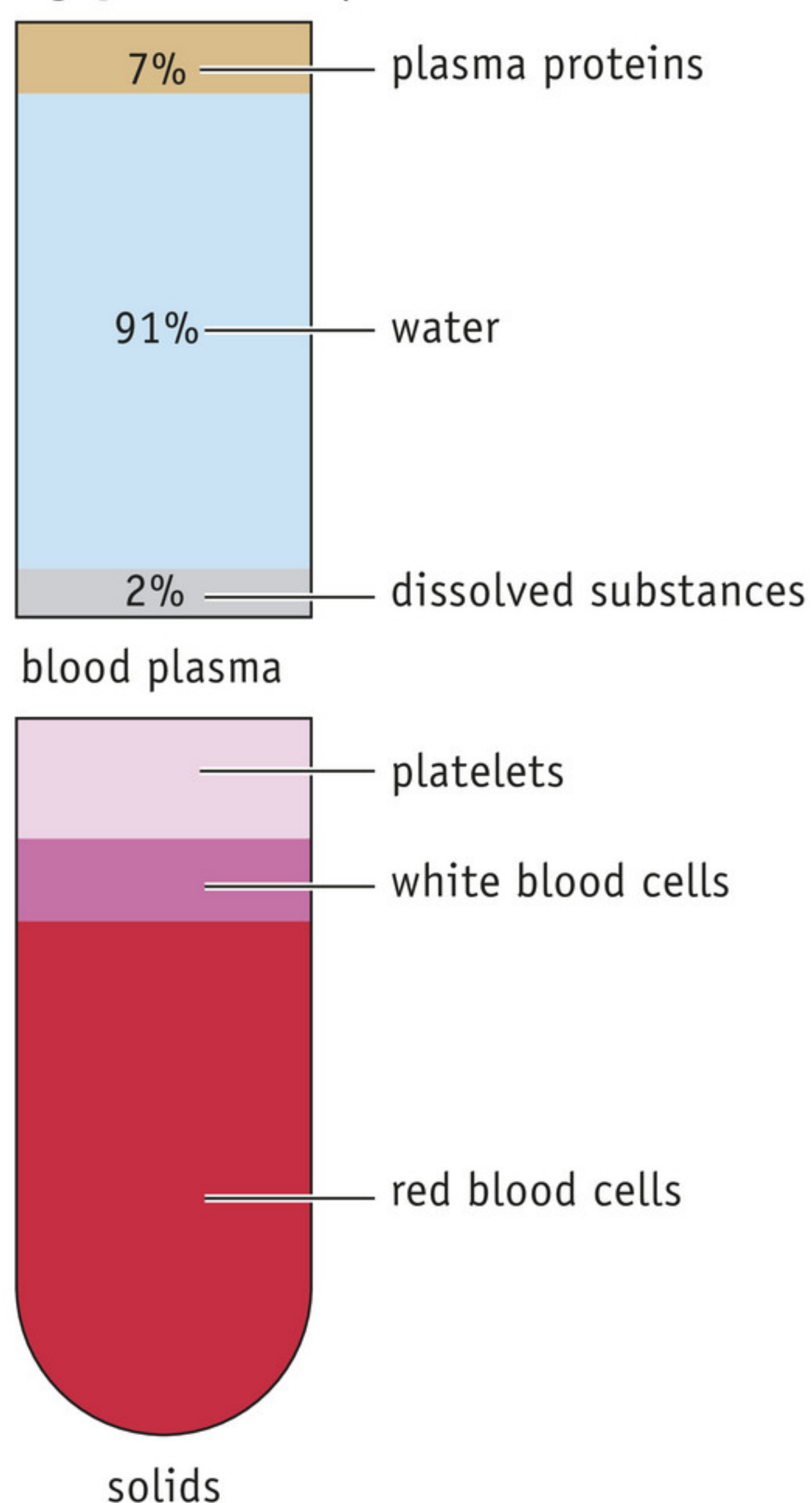
fig. 2 Test tubes of blood.



BLOOD PLASMA

Blood plasma consists of 7% protein (plasma proteins) and 91% water (see figure 3). The rest of the blood plasma consists of substances dissolved in the water, including minerals (salts). One of the plasma proteins is **fibrinogen**. Fibrinogen plays a role in clotting. Blood plasma transports lots of substances, including nutrients, waste products (such as carbon dioxide) and even just a little bit of oxygen.

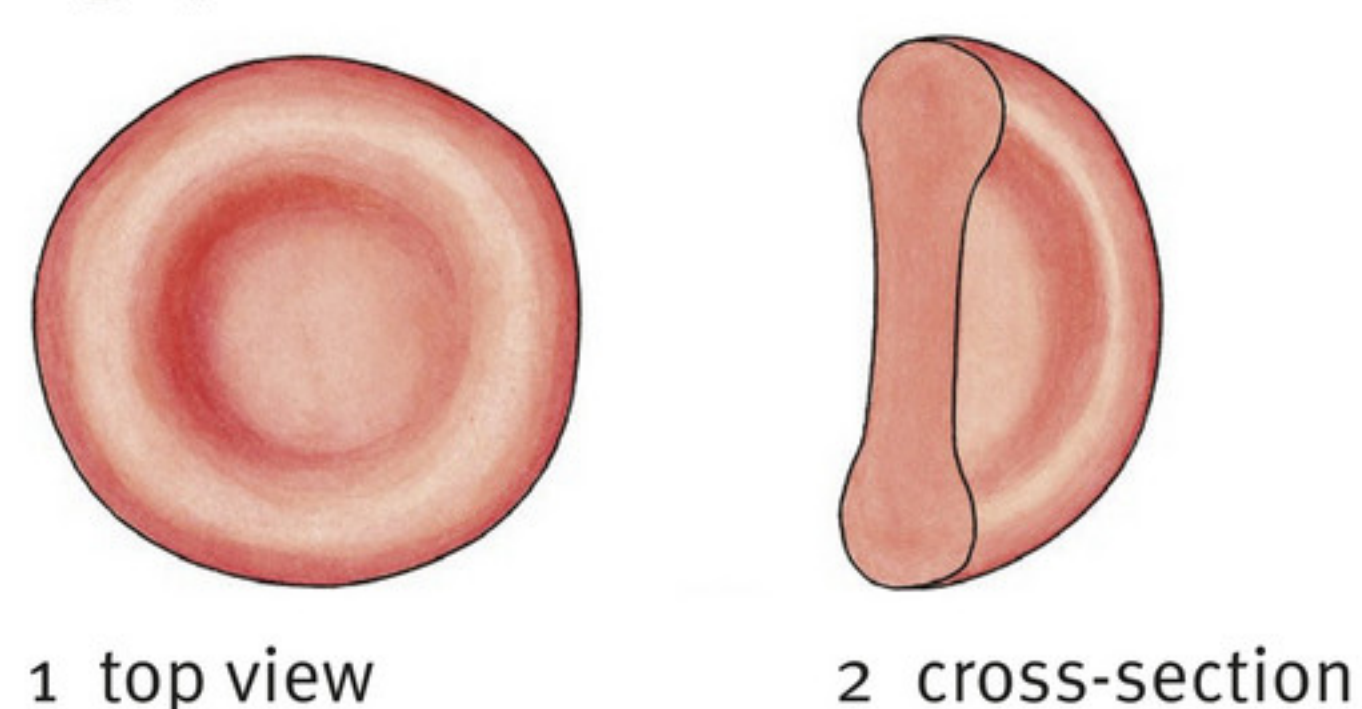
fig. 3 The composition of blood.



RED BLOOD CELLS

Red blood cells are shaped like small, round discs. They are a bit thinner at the centre than the outer edges (see figure 4). Red blood cells do not have a nucleus. One cubic millimetre ($1 \text{ mm}^3 = 0.001 \text{ mL}$) of blood contains about five million red blood cells.

fig. 4 A red blood cell.



Red blood cells are primarily for carrying oxygen. They contain a red-coloured protein called **haemoglobin**. Haemoglobin can hold oxygen and also release it again. This lets the red blood cells absorb and release oxygen easily. In the lungs, red blood cells absorb oxygen; in other organs, they release it.

WHITE BLOOD CELLS

Unlike red blood cells, white blood cells do have a nucleus (see figure 5). The cells do not have a fixed shape. This lets them squeeze through small openings in the walls of the smallest blood vessels (see figure 6). One cubic millimetre of blood contains about seven thousand white blood cells.

White blood cells can eliminate pathogens: germs such as bacteria and viruses. One type of white blood cell does that by ingesting the pathogens and destroying them. In most cases, this means that the white blood cell itself also dies.

fig. 5 White blood cells (blue).

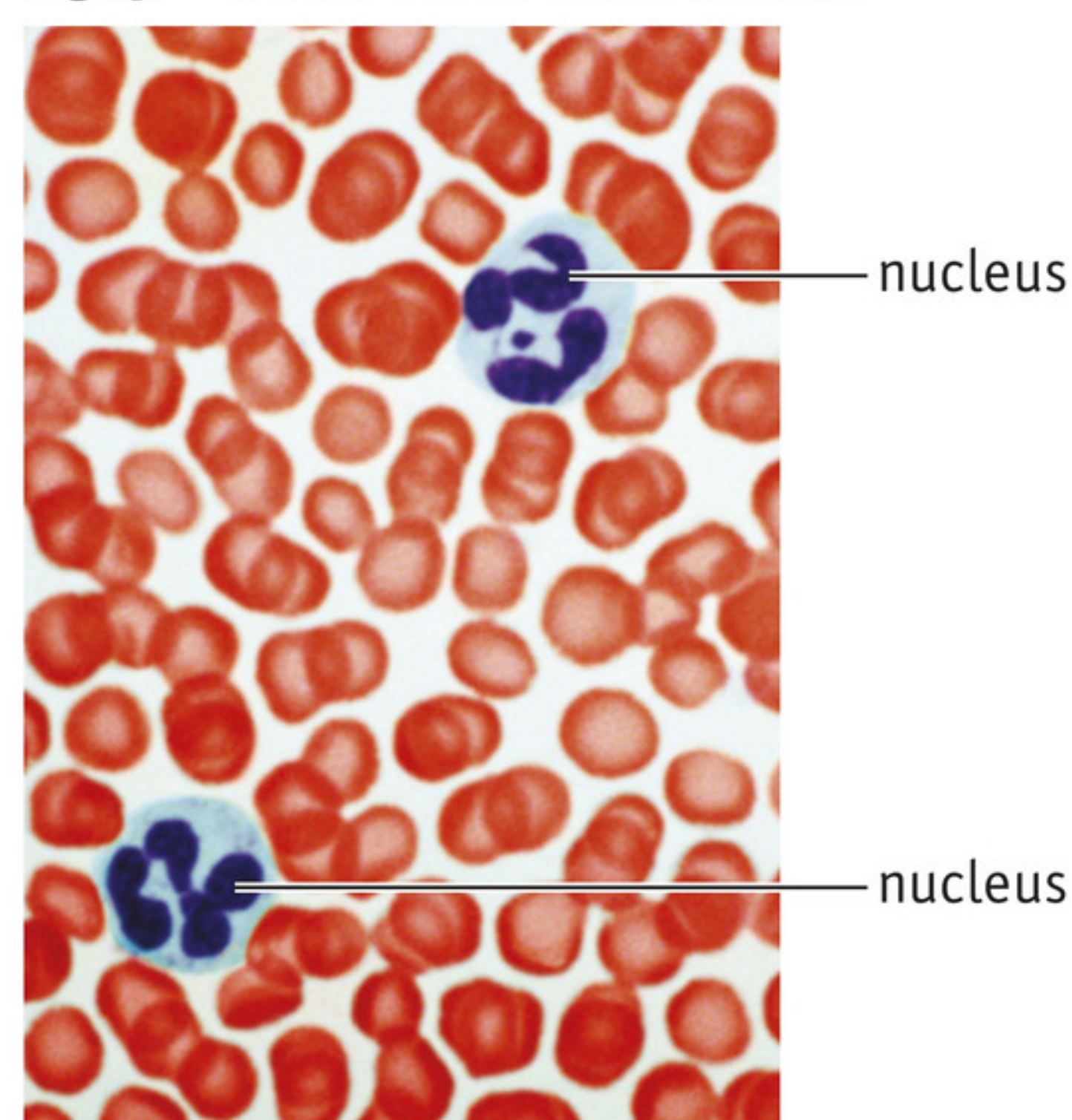
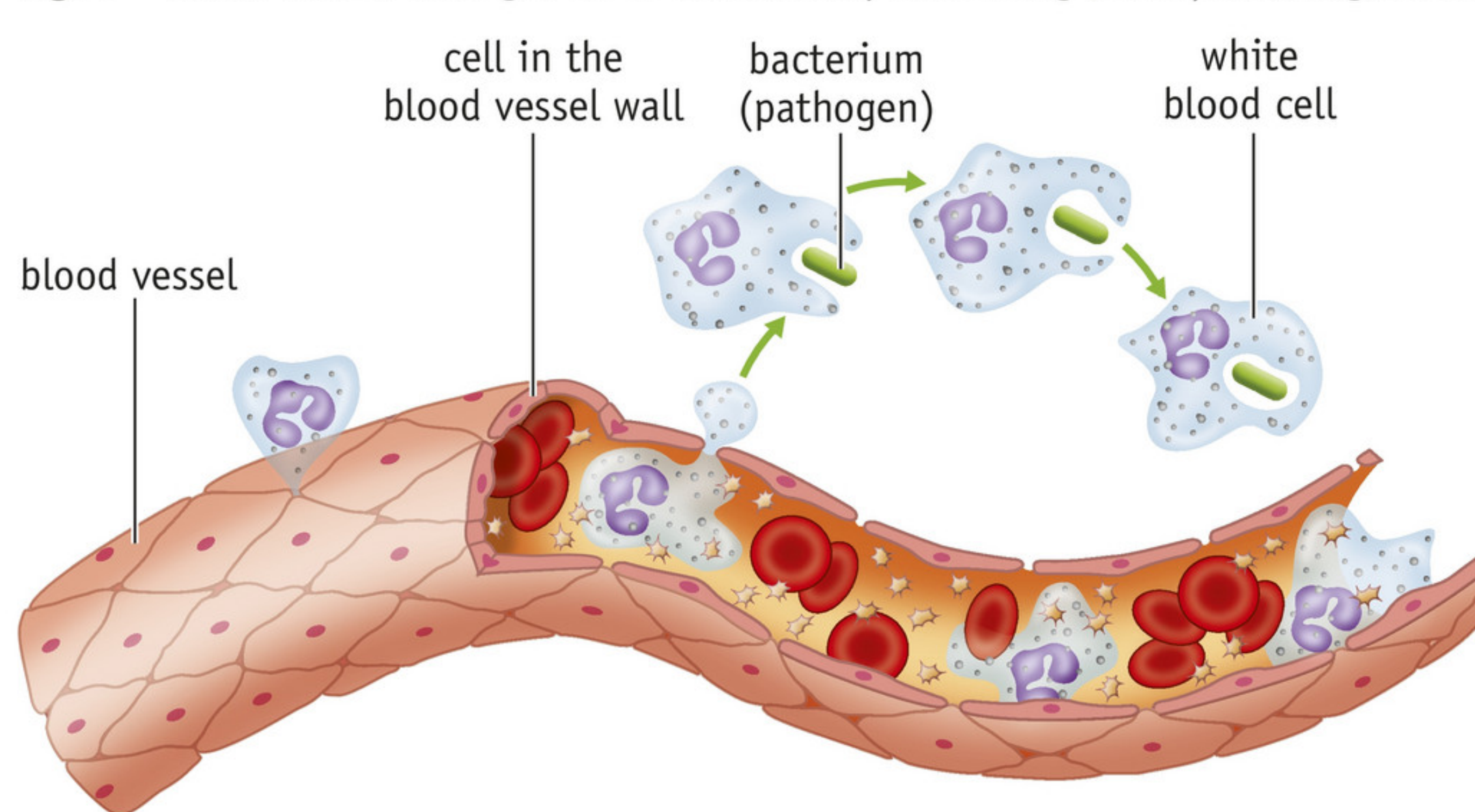


fig. 6 White blood cells get rid of bacteria by enclosing (encapsulating) them.



BLOOD PLATELETS

Platelets are not cells: they are parts of broken-up cells (see figure 7). This means they do not have a nucleus. One cubic millimetre of blood contains about three hundred thousand (300,000) platelets.

Platelets are needed for **clotting**. They contain substances that make the blood clot (coagulate) when it gets outside the blood vessels (see figure 8).

fig. 7 Platelets (yellow).

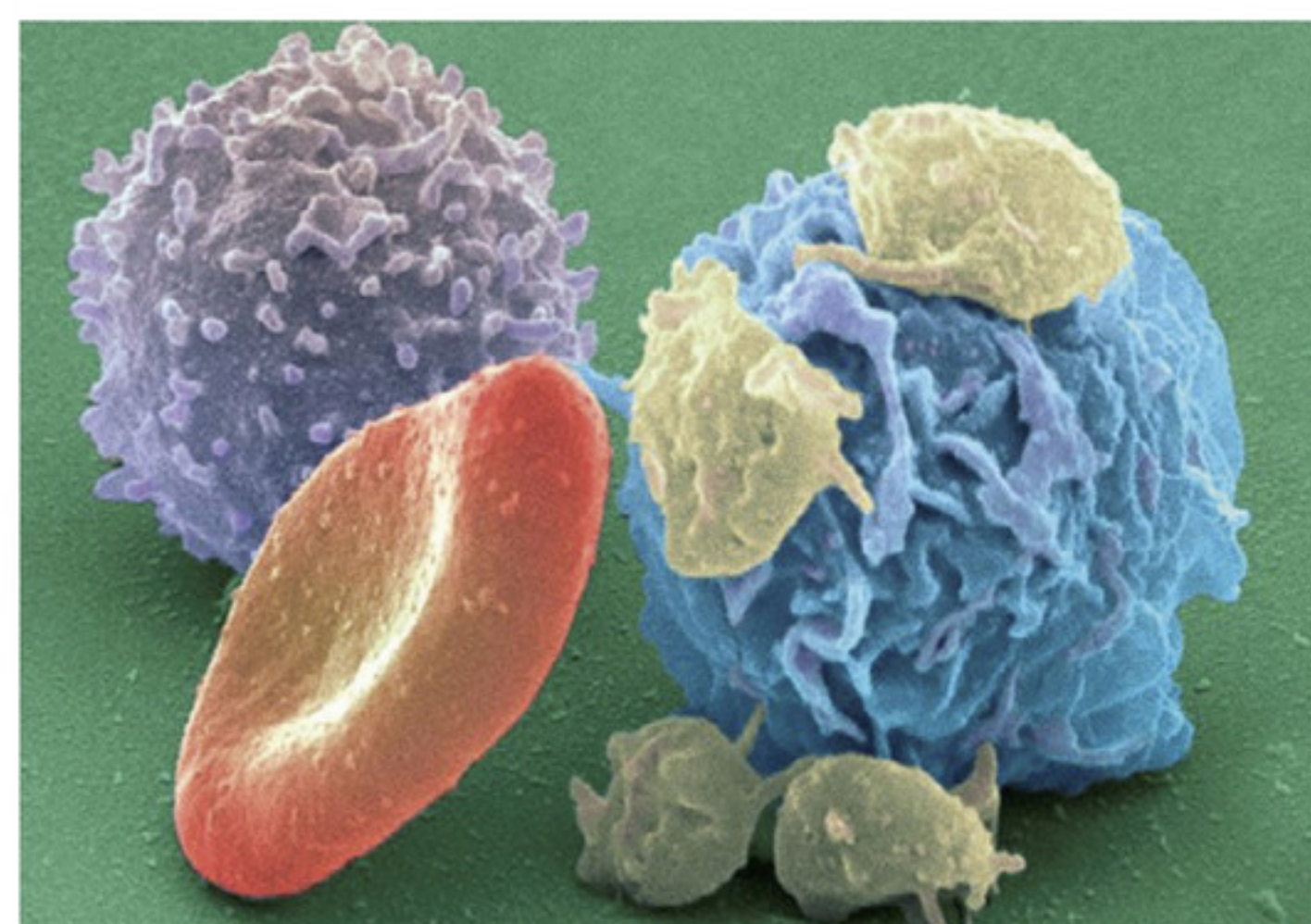


fig. 8 When there is an injury, platelets make the blood clot.



KNOWLEDGE

1

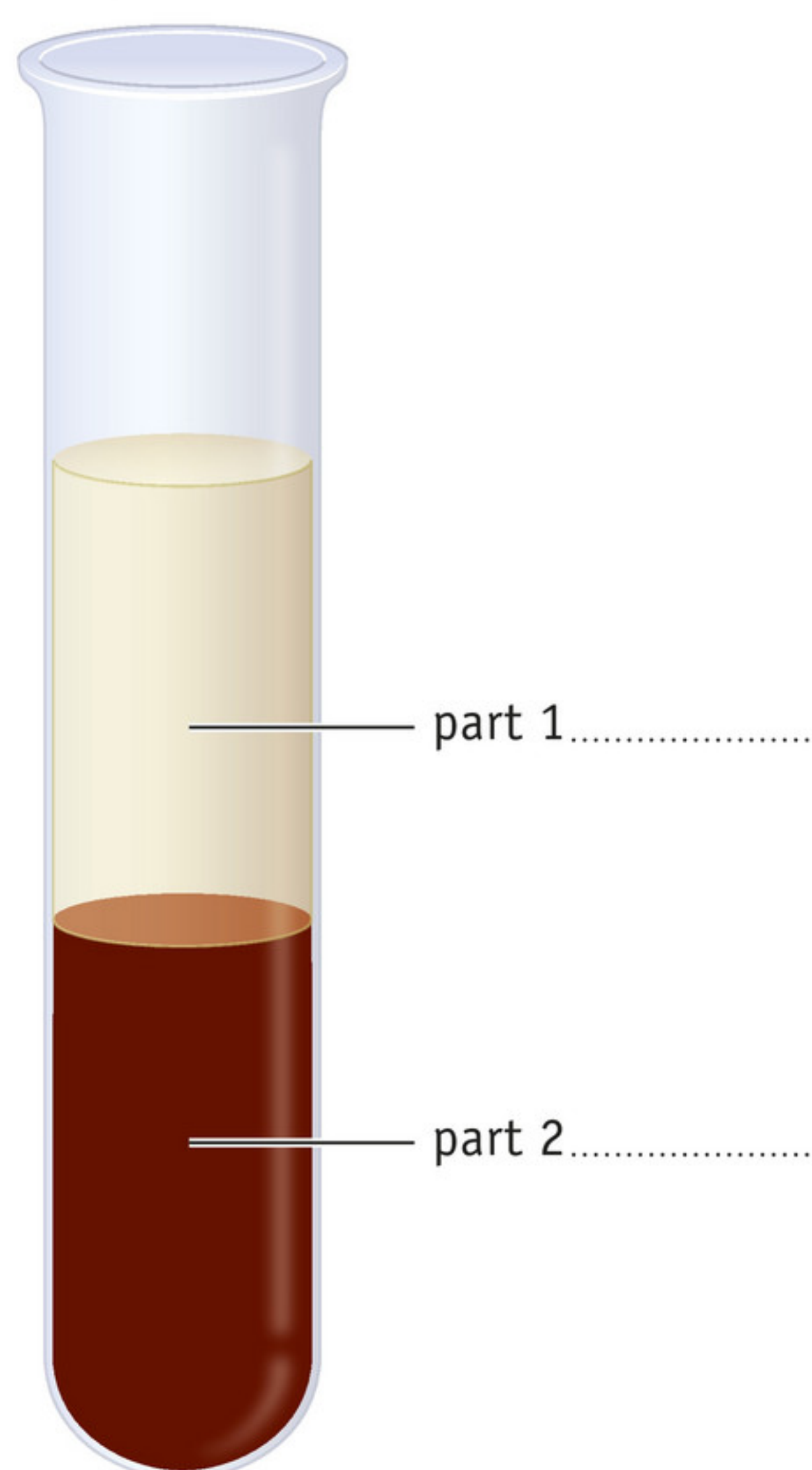
- a** What is blood made up of?
b Figure 9 is a drawing of a test tube with blood. The blood has separated into two parts, numbered 1 and 2.

What does part 1 consist of?

- c** Which substances does part 2 contain?

- d** Put the percentages behind parts 1 and 2.

fig. 9 A test tube with blood.

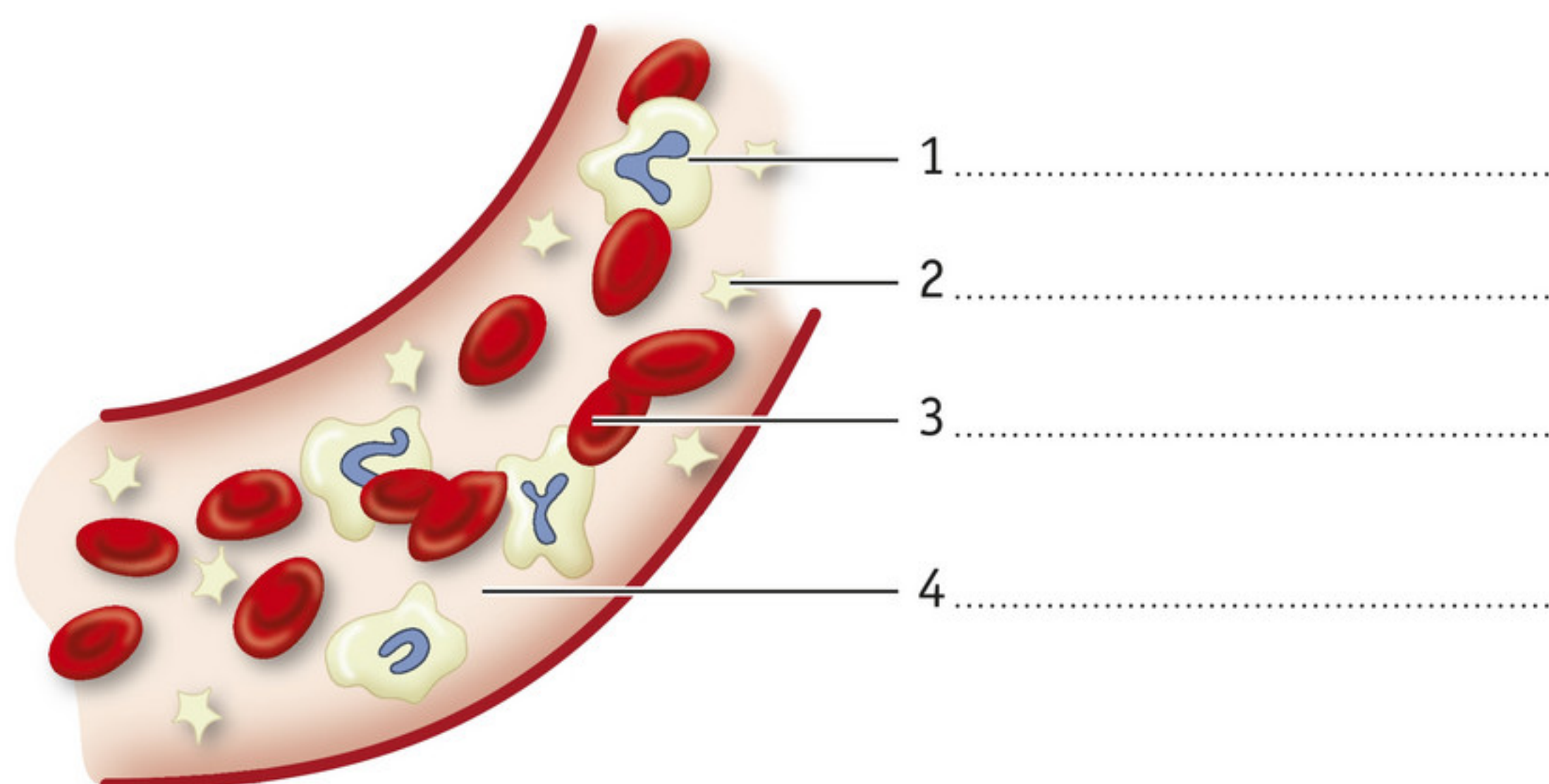


2

Figure 10 shows a schematic drawing of a blood vessel.

- a** Write down the names of the numbered parts.
b Put the blood components in the right order, from many to few.

fig. 10 Schematic drawing of a blood vessel.



3

- a** Which part of the blood renders pathogens harmless?
- ☐ A platelets
 - ☐ B blood plasma
 - ☐ C red blood cells
 - ☐ D white blood cells
- b** One of the substances that tobacco smoke contains is carbon monoxide. In the blood, carbon monoxide takes up the sites where oxygen is normally held. What part of the blood does carbon monoxide stick to?
- ☐ A platelets
 - ☐ B blood plasma
 - ☐ C red blood cells
 - ☐ D white blood cells
- c** In an inflamed wound, pus can form.
Pus contains killed bacteria and dead *red / white* blood cells.
- d** Which three statements about white blood cells are correct?
- ☐ A They can pass outside the smallest blood vessels.
 - ☐ B They can enclose and absorb smaller cells.
 - ☐ C They can move between the tissue cells.
 - ☐ D They can easily split into two.
 - ☐ E They can transport oxygen.
 - ☐ F They are smaller than red blood cells.
 - ☐ G They are needed for blood clotting.
- e** In someone with anaemia, the blood cannot carry enough oxygen.
Which blood component (or components) does a person with anaemia not have enough of? Explain your answer.

4

In a bruise, small blood vessels are damaged. The blood clots in the skin, preventing further internal blood loss.

- a** Which protein in blood plasma is needed for blood clotting?
- b** What component of blood is needed for blood clotting?
platelets / red blood cells / white blood cells
- c** A bruise changes colour because a pigment is broken down.
What is this pigment called?

5

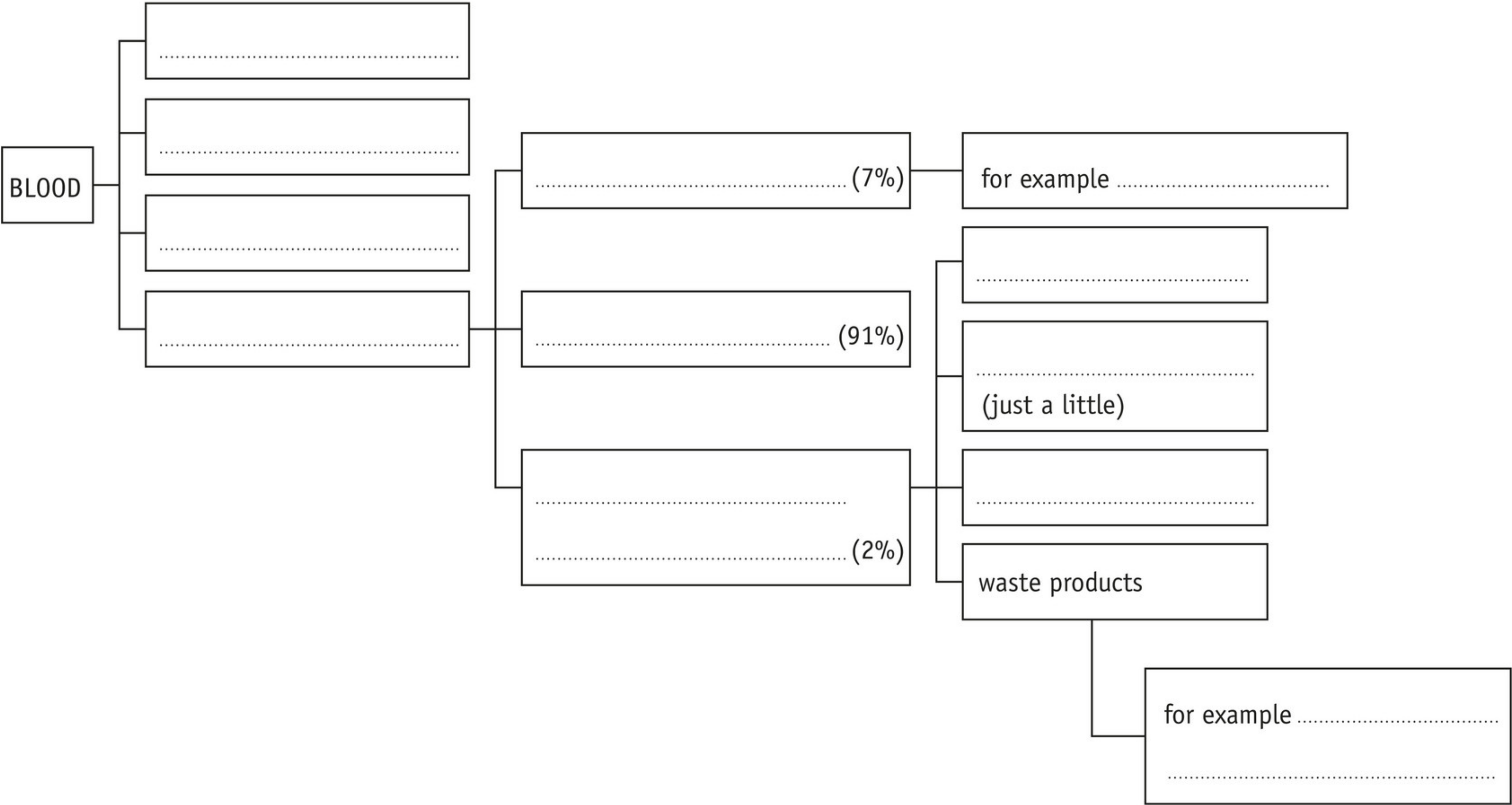
Summary



Complete the table and diagram in figure 11.

	Red blood cells	White blood cells	Blood platelets
1 Do they have a nucleus?			
2 What is their function?			

fig. 11



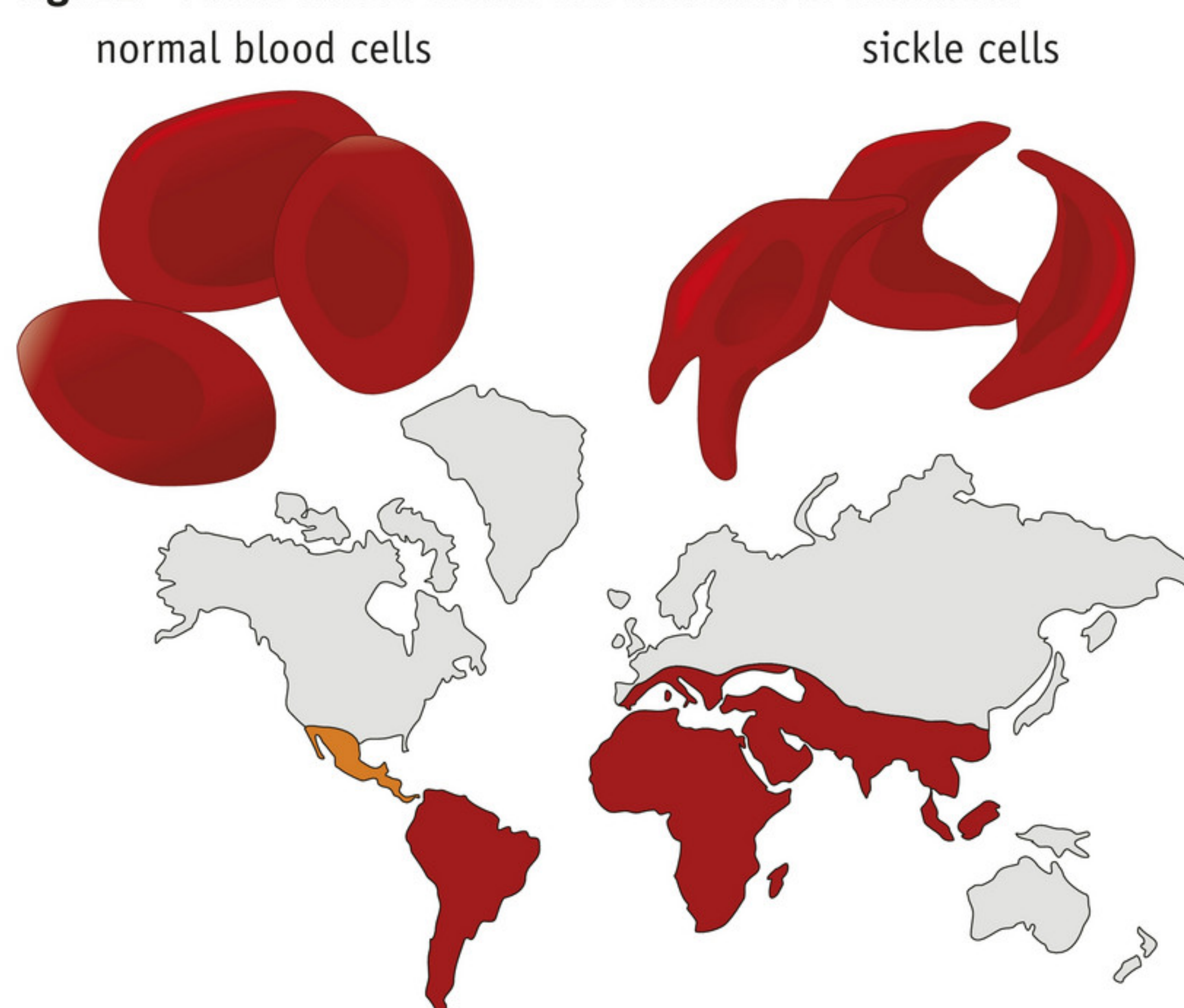
INSIGHT

6

Sickle cell anaemia is a hereditary disease in which certain components of the blood cannot perform their task properly. They may also have an abnormal shape. This disease is common in South America and Africa (see figure 12).

- Which blood particles have an abnormal shape in sickle cell anaemia?
platelets / red blood cells / white blood cells
- What task can the abnormal blood cells in sickle cell anaemia not perform properly?
- What will be the effects (symptoms) of sickle cell anaemia on a patient? Explain your answer.

fig. 12 Areas where sickle cell anaemia is common.



7

When blood coagulates inside the blood vessels, a blood clot forms in a blood vessel. This is called thrombosis. A blood clot like this can close off a blood vessel, stopping blood from flowing through it. In the heart or brain, this can be very dangerous.

- Why is thrombosis in the heart or brain so dangerous?
- Patients with thrombosis must take medication.
What side effects can these medicines have? Explain your answer.

8

Blood loss can occur due to a fall from your bicycle, a cut on your finger or surgery. In most cases, this is not a big problem, but in someone with haemophilia, this blood loss can be so severe that they die.

- Why is a wound or cut normally not a big problem?
- What is wrong in haemophilia?
- Which blood particles do not work well in haemophilia?

+ 9

Epo (erythropoietin) is a hormone produced by the kidneys that stimulates the production of red blood cells. It is used as a medicine for anaemia. Endurance athletes also use epo as a performance-enhancing drug. Examples of endurance sports are race cycling and distance running.

- Explain why endurance athletes in particular benefit from a higher red blood cell count.
- A big increase in the red blood cell count can make the blood thicker (more viscous). Explain why this can be dangerous.

HOW IT FITS TOGETHER biology in professional life

SENIOR HAEMATOLOGY ANALYST

Mark Siderius is a senior haematology analyst (haematology is about blood and blood diseases) at the clinical chemistry laboratory of the Meander Medical Centre in Amersfoort.

“In my profession, it’s obviously important that you know all about blood. As a lead haematology analyst, I’m responsible for the work in our laboratory. At the lab, we study abnormalities in the blood and blood-forming organs. For example, we might investigate the composition of patients’ blood to find out which disease they have and how it is progressing. We also check whether a treatment is effective. Our laboratory also studies the blood of people with thrombosis or haemophilia. In these people, the blood is either clotting too well or not enough. We also study blood transfusions. During a blood transfusion, blood (or blood components) is administered to the patient. I find it fascinating to figure out which blood is suitable for a patient.

Every day, I deal with all kinds of diseases – some of them very serious – but I also work on effective treatment methods. The most wonderful moments in my work are when we find abnormalities a doctor does not expect so that we can help the patient quickly. After all: the sooner the treatment starts, the greater the chance of success.”

fig. 13 Mark Siderius in his laboratory.



10

Read the text ‘Senior Haematology Analyst’.

Mark has a test tube with 10 mL blood. Using a centrifuge, he separates the blood plasma from the solid components. He puts the blood plasma in a separate test tube.

- a** Roughly how many millilitres of blood plasma will he have? Round the answer off to one decimal place.

About mL.

- b** In patients with haemophilia, the blood does not coagulate well.
Which two components of the blood are mainly tested at the laboratory in cases of haemophilia?
- c** The haematological laboratory also studies glandular fever. This disease is also sometimes called the ‘kissing disease’, because infection often occurs through the transfer of saliva. The flu-like symptoms and long-term fatigue are caused by less effective control of pathogens.
Which type of blood cells does the lab technician look for when testing for glandular fever? Explain your answer.
- d** In glandular fever, these blood cells are larger than normal.
This is because the cell’s cytoplasm contains more

 Go to the *Flash cards* and the *Test yourself* section.

2 The circulatory system

LEARNING OBJECTIVES

- 3.2.2 You can name three types of blood vessels with their features and functions.
 3.2.3 You can name arteries and veins in the human circulatory system.
 3.2.4 You can distinguish between the pulmonary and systemic circulation with their functions.

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES		
	3.2.2	3.2.3	3.2.4
Remembering	1a	3ab	
Understanding	1bcde, 2, 5, 11b	3cde, 5	4, 5
Using	6a, 11d	6a, 7bc, 9b	7abc, 8a
Analysing	10, 11ac	6bc, 9a	6bc, 8bc

The blood carries useful substances to all cells. The blood disposes of the cells' waste products. A strongly branched network of blood vessels reaches everywhere in your body.

BLOOD VESSELS

The human circulatory system consists of the heart and the blood vessels. Large and small blood vessels run throughout the body. The heart pumps blood through the blood vessels. The path that the blood takes through the body is called the **circulation**.

There are three types of vessels: arteries, capillaries and veins (see figure 1).

The heart pumps blood into the **arteries**. Blood flows forcefully through the arteries from the heart to the organs.

In the organs, the arteries branch into increasingly smaller vessels (see figure 2). The walls of the blood vessels get thinner and thinner. The smallest blood vessels are called **capillaries**. The wall of a capillary is only one cell layer thick.

The capillaries then come together again into larger vessels, the **veins**. The blood flows back to the heart through the veins.

fig. 1 Three types of vessels.

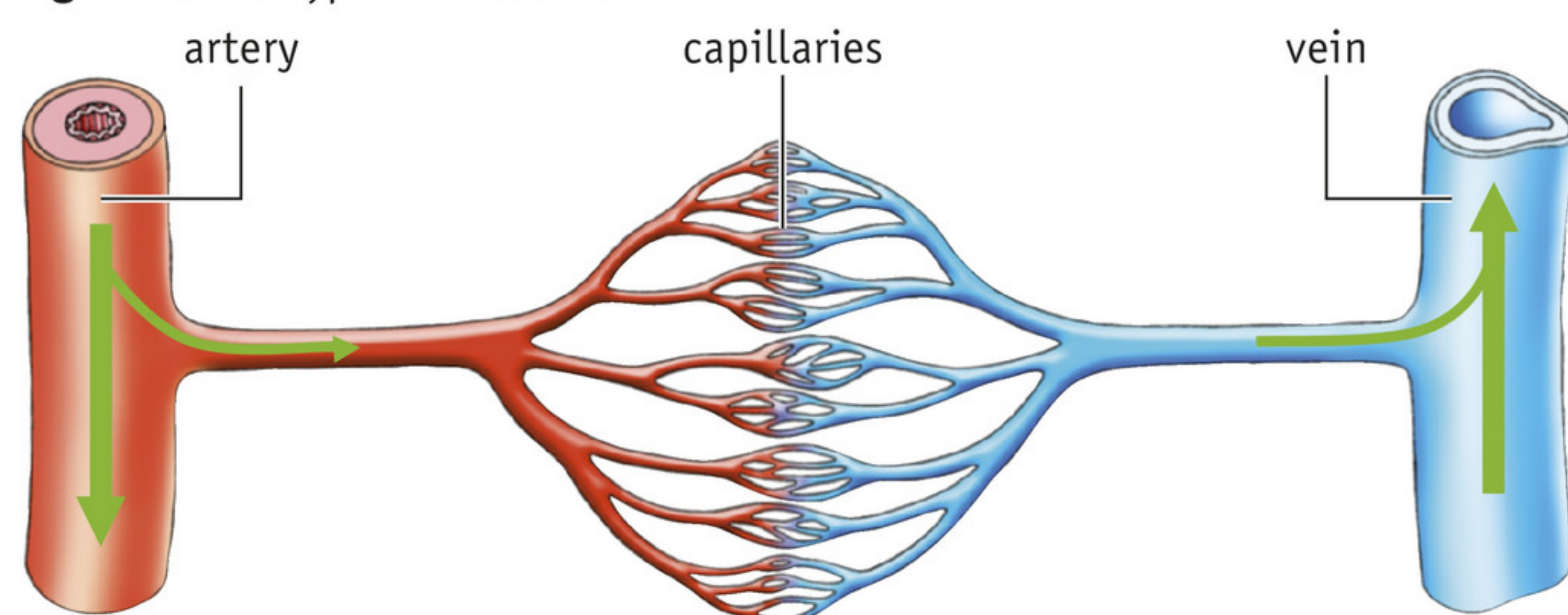


fig. 2 The vessels in a hand.



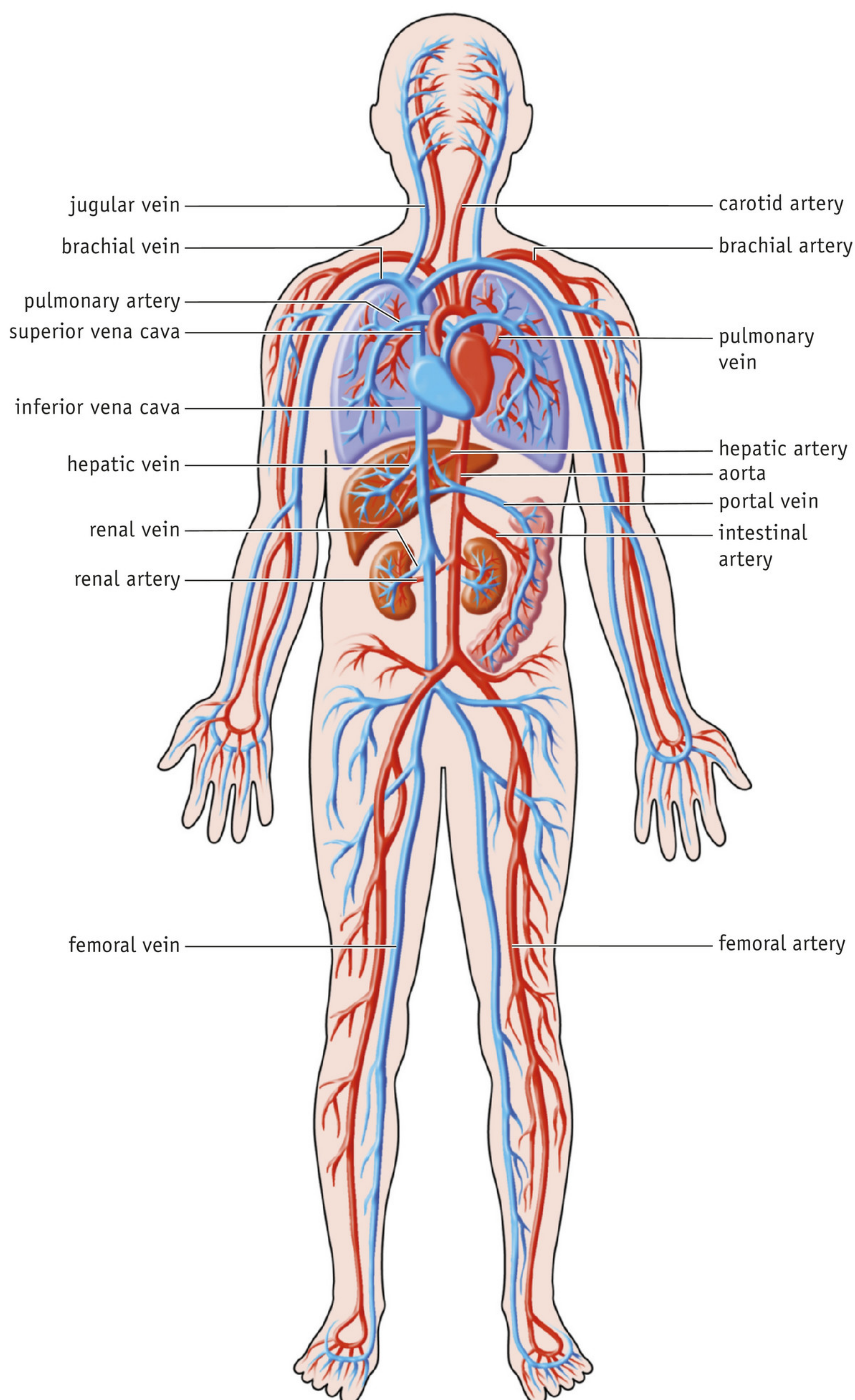
THE CIRCULATORY SYSTEM

Figure 3 shows a diagram of the human **circulatory system**. The capillaries have been left out. In the red-coloured blood vessels, the blood is oxygen-rich. The blood in the blue-coloured blood vessels is low in oxygen. In reality, oxygen-rich blood is bright red and unoxygenated blood is dark red.

Arteries and veins have names based on the organ they come from or go to (sometimes derived from Latin). For example, the femoral artery (from femur) supplies blood to the legs; the femoral vein carries the blood away from the legs. Two veins and one artery of the heart have special names: the inferior vena cava, superior vena cava and the aorta.

Another exception is the **portal vein**. This vein transports blood from the wall of the intestinal tract to the liver. This blood is low in oxygen because the oxygen is used in the intestinal tract for cellular respiration. In the small intestine, nutrients are absorbed into the blood. The composition of the blood in the portal vein can therefore vary greatly: after a meal, the blood contains a lot of nutrients.

fig. 3 The human circulatory system.



DOUBLE CIRCULATORY SYSTEM

The heart is a double pump. The right side of the heart pumps blood to the left and right lungs. From the lungs, the blood flows back to the heart. This part of the circulation is called the **pulmonary circulation** (see figure 4).

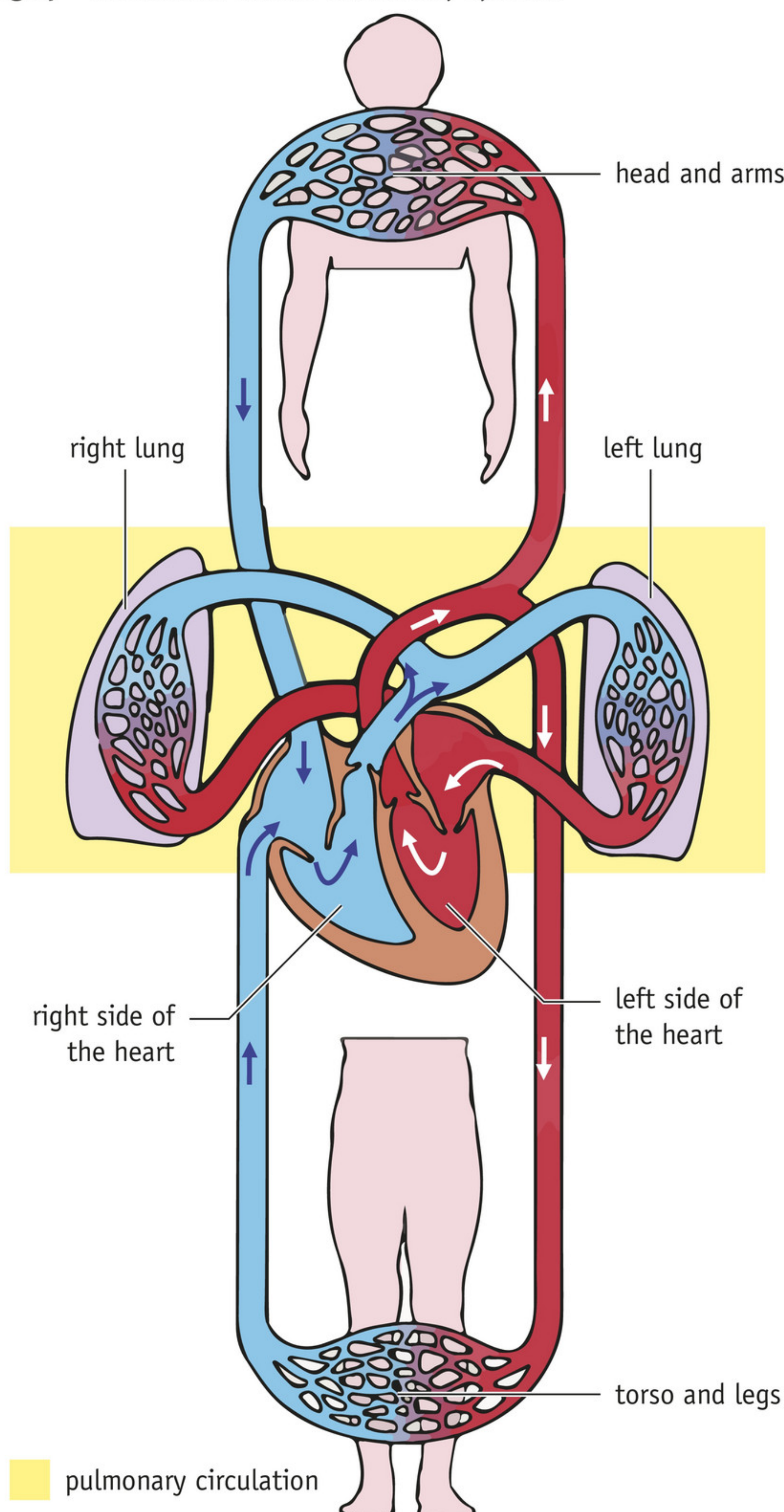
In the pulmonary circulation, oxygen is absorbed into the bloodstream and carbon dioxide is released into the air. That happens in the lungs.

Blood from the pulmonary circulation enters the left side of the heart. That side of the heart pumps the blood through organs throughout the whole body. From the organs, the blood flows back to the right half of the heart. This part of the circulation is called the **systemic circulation**.

The systemic circulation carries oxygen and nutrients (including glucose) to the cells, while carbon dioxide and other waste products are absorbed into the bloodstream.

In each complete circuit, the blood passes through the heart twice. That is why you call the human circulation a **double circulatory system**. Mammals and birds have a double circulatory system.

fig. 4 The human double circulatory system.

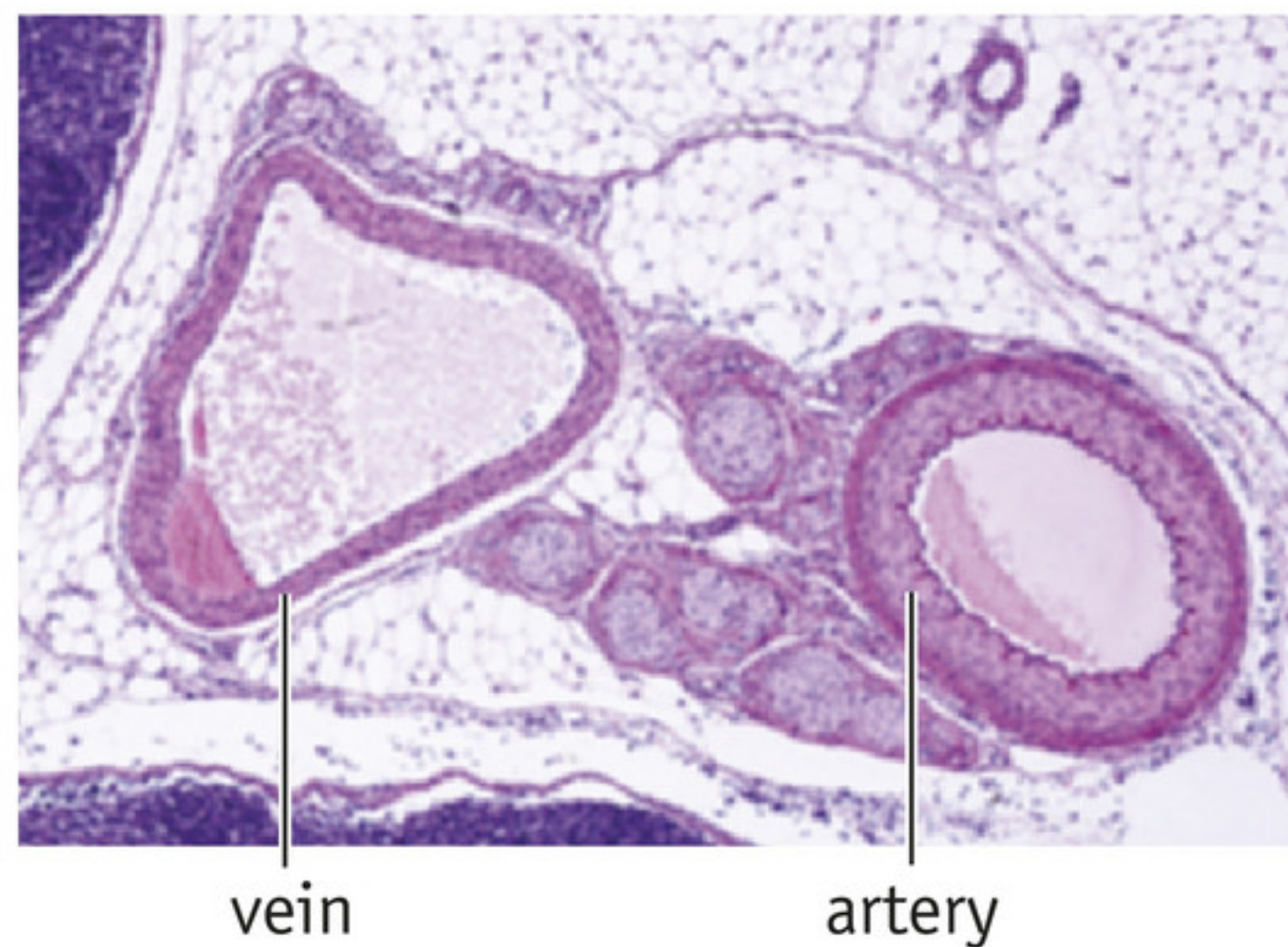


ARTERIES

The heart pumps blood into the arteries. As a result, the blood pressure on the walls of arteries is high. The walls of the arteries are therefore thick, muscular and elastic (see figure 5).

When the heart pushes blood into the arteries, they expand. Afterwards they spring back into shape. You can feel this when you hold your wrist (the pulse). In the wrists, the arteries run just under the skin. Most arteries lie deeper in the body, where they cannot be damaged easily.

fig. 5 Vein and artery (cross section).



CAPILLARIES

Blood pressure decreases dramatically in the capillaries. Fluids containing oxygen and nutrients can exit the capillaries into the cells through the thin walls of the capillary vessels. White blood cells can also exit a capillary through the wall.

The cells use the oxygen and nutrients for respiration. This releases carbon dioxide and other waste products. Fluids containing carbon dioxide and other waste products can be absorbed into the capillaries through their thin walls.

VEINS

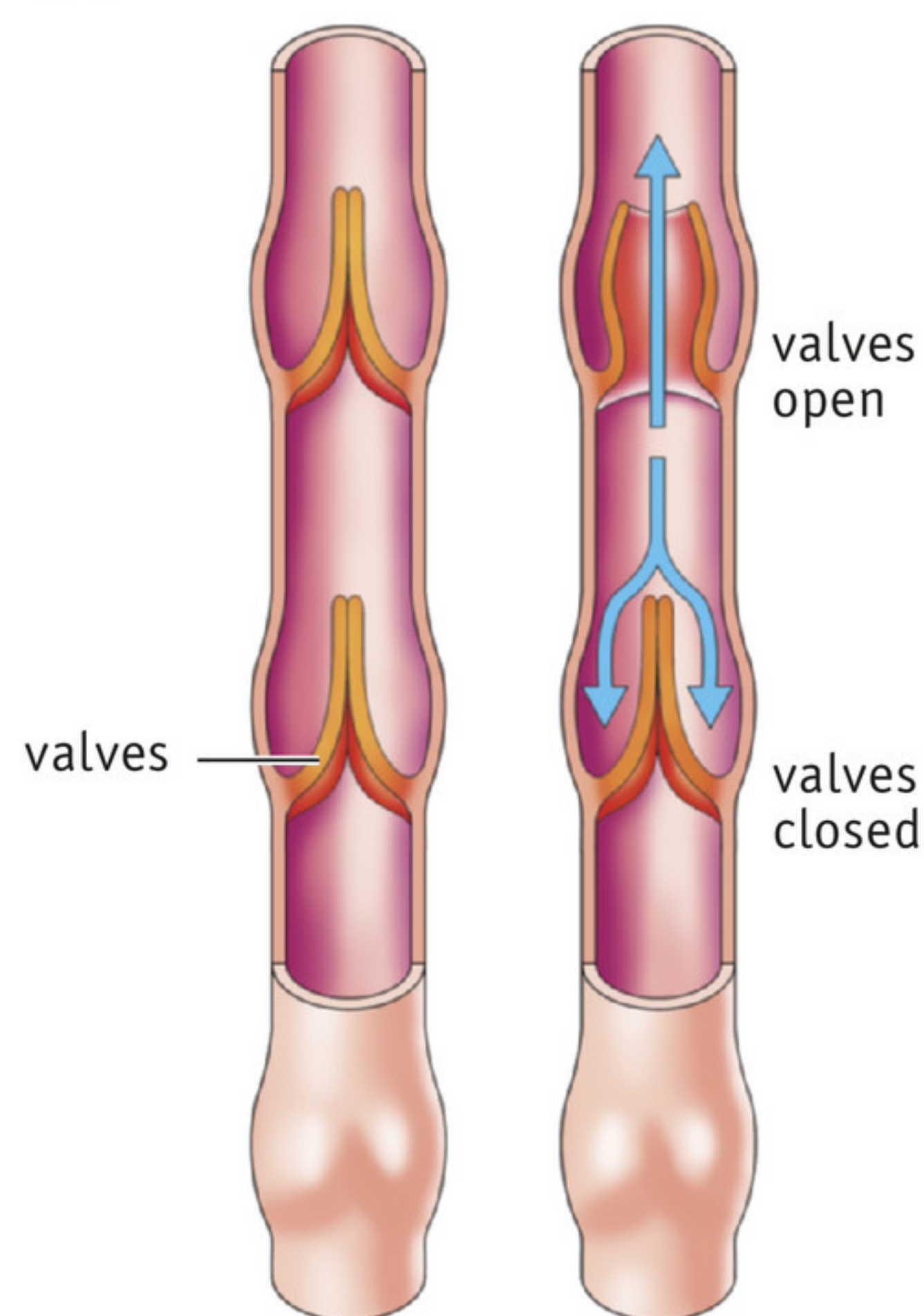
The capillaries come together to form veins. The blood pressure in veins is low, so the walls of the veins are thinner and less elastic than those of the arteries (see figure 5). The veins do not have a detectable pulse. Veins generally run closer to the body's surface. You can see them in your hands as blue lines (see figure 6).

fig. 6 Veins.



The heart draws blood back in from the veins. A lot of veins, especially in the arms and legs, have **valves**. The venous valves only let the blood flow in one direction (see figure 7). The valves help to lead the blood back to the heart. They also prevent the blood from flowing back to the organs due to gravity.

fig. 7 Valves.



1 longitudinal section 2 How the venous valves work

KNOWLEDGE

1

a Which type of blood vessel is each of these sentences about?

- | | | |
|---|-----------------------|--------------------------------------|
| A The blood flows back to the heart through the | ☐ | ☐ 1 veins. |
| B The heart pumps the blood into the | ☐ | ☐ 2 capillaries. |
| C The exchange of substances between cells and blood takes place in the | ☐ | ☐ 3 arteries. |

b A blood vessel with a muscular wall transports oxygen-rich blood. What type of vessel is this sentence about?

- ☐ A vein
☐ B capillary
☐ C artery

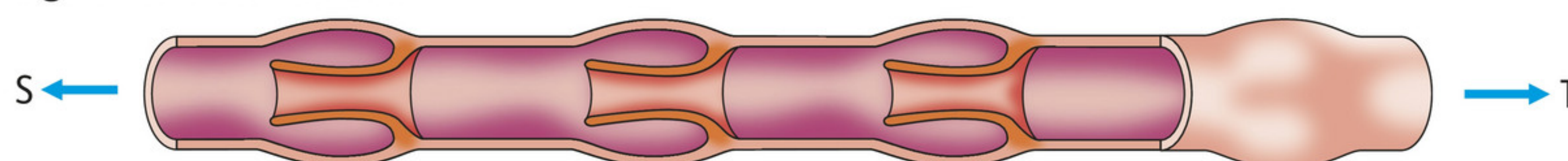
c What makes arterial bleeding more dangerous than bleeding from a vein?

d Figure 8 is a schematic drawing of a blood vessel.

Is this blood vessel a vein, a capillary or an artery? Explain your answer.

e Which direction can the blood flow in through this vessel: in the direction of arrow S, arrow T or both? Explain your answer.

fig. 8 A blood vessel.

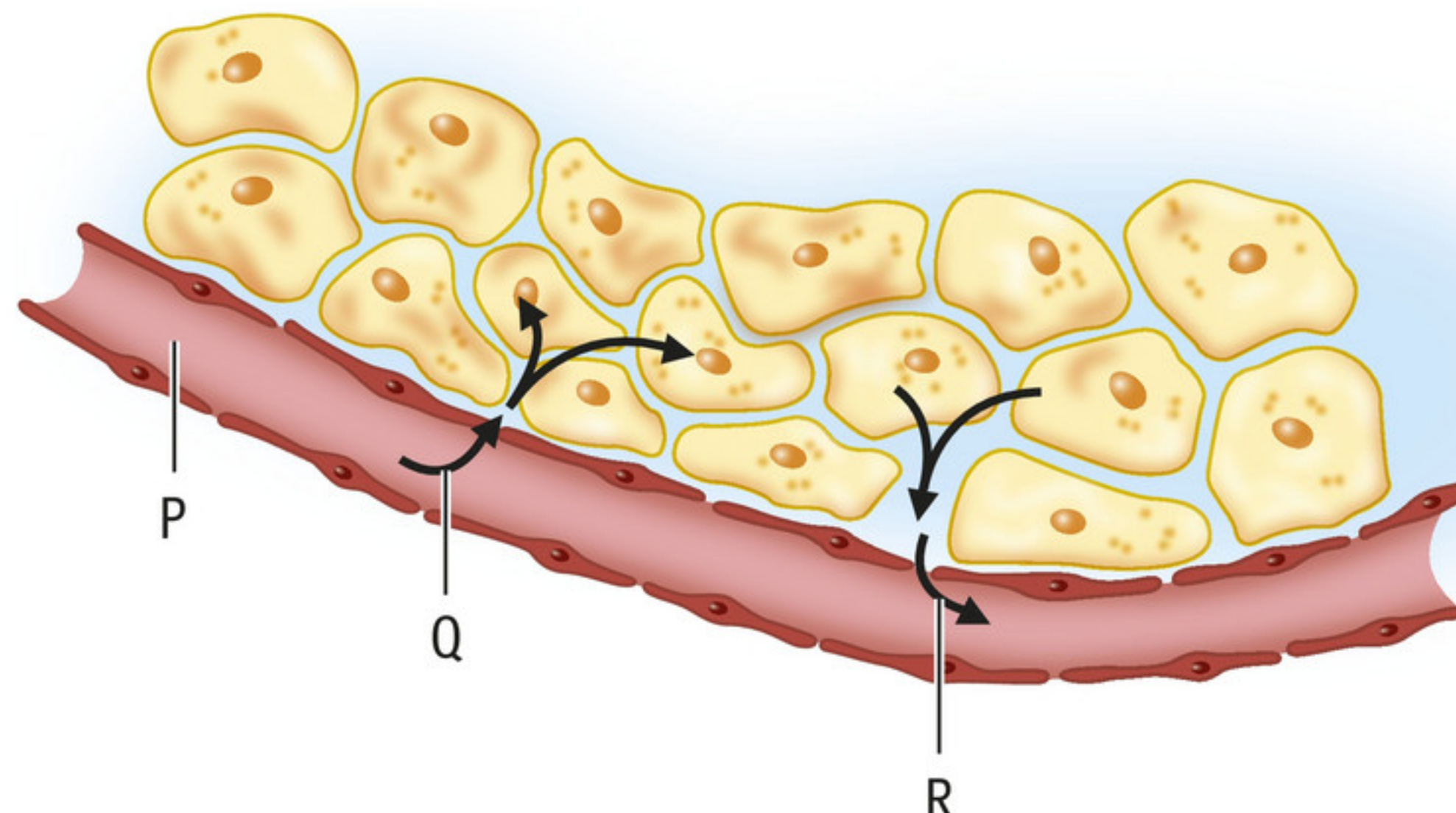


2

Figure 9 shows a drawing of a piece of tissue with a blood vessel.

- a** Vessel P is *a vein / a capillary / an artery*.
- b** What transported substances move at arrow Q from the vessel to the tissue?
- c** What substances go from the tissue to the vessel at arrow R?

fig. 9 A piece of tissue with a blood vessel.



3

Most arteries contain oxygen-rich blood.

- a** Which arteries contain blood that is low in oxygen? Explain your answer.
- b** Which veins contain oxygen-rich blood? Explain your answer.
- c** Which artery does oxygen-rich blood flow through to the liver?

through the

Which vein does deoxygenated blood flow through to the liver?

Through the

- d** The blood fed from the intestinal wall to the liver is low in oxygen. Why?
- e** In which vein does the blood contain a lot of nutrients after a meal? Explain your answer.

4

- a** Why is the human circulation called a double circulatory system?
- b** Which vessels (arteries/veins) to and from the heart belong to the systemic circulation?
 - ☐ A aorta
 - ☐ B superior vena cava
 - ☐ C pulmonary veins
 - ☐ D pulmonary arteries
 - ☐ E inferior vena cava
- c** Is there a vessel (artery/vein) that belongs to both the pulmonary and the systemic circulation? *yes / no*
- d** Which two functions does the pulmonary circulation have?
- e** Which functions does the systemic circulation have?

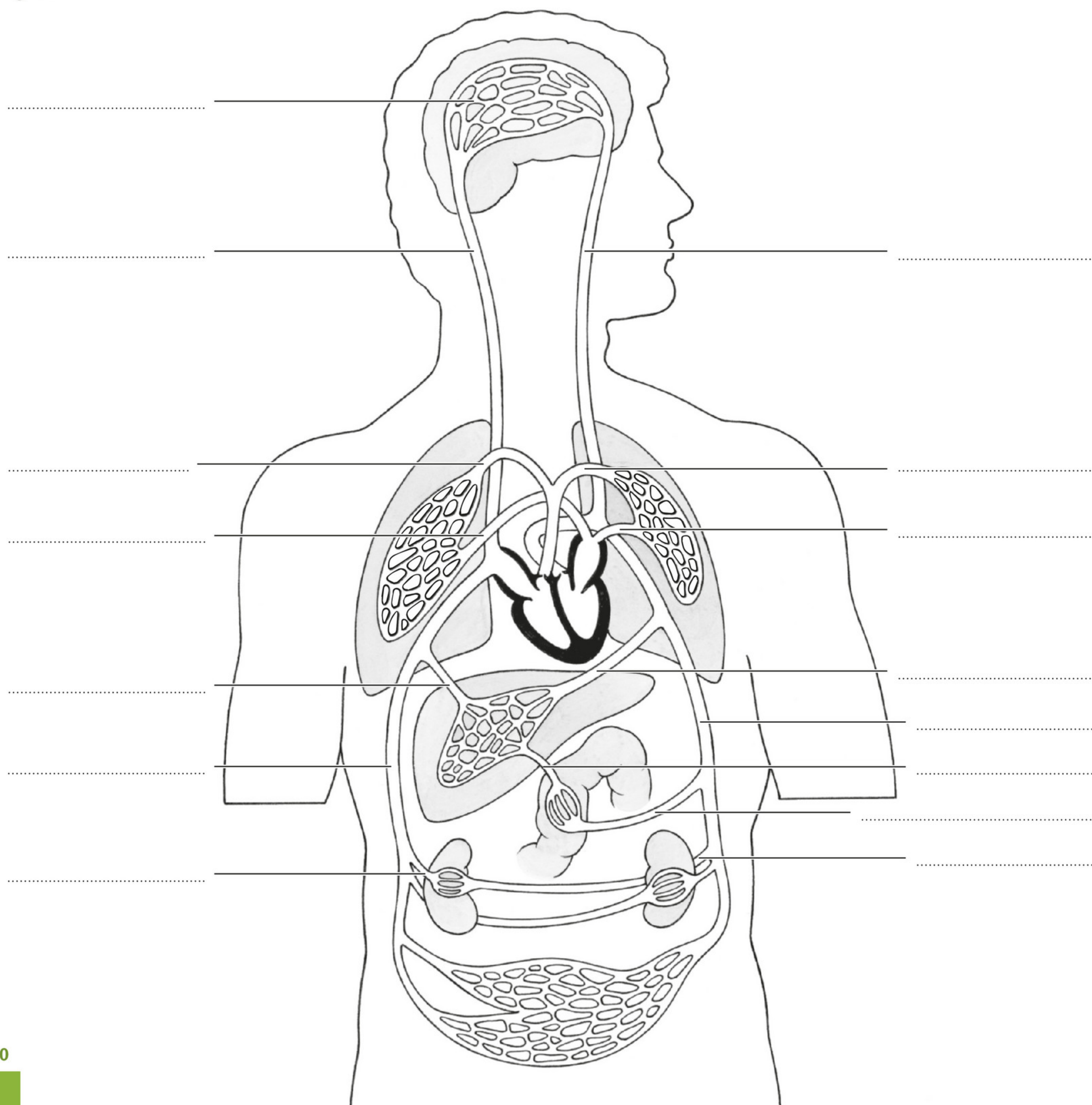
5

**Summary**

- Make drawings of the three types of blood vessels with their characteristics.
- Also show the direction of the blood flow in the drawing.
- Write down the names next to the blood vessels in figure 10.
- Use arrows to indicate the direction that the blood is flowing in.
- Highlight the names of the blood vessels that deoxygenated blood flows through.
- Colour in the blood vessels of the pulmonary circulation.



fig. 10



INSIGHT

6

Blood transports substances including oxygen, carbon dioxide and glucose.

- a** Compare the blood in an artery to a muscle with the blood from one of that muscle's veins. The muscle is very active at that time.

In which vessel does the blood have:

- the higher temperature? *vein / artery*
- the higher glucose content? *vein / artery*
- the higher carbon dioxide content? *vein / artery*
- the higher oxygen content? *vein / artery*

- b** For which of these variables is the value at the entrance to the pulmonary artery and at the entrance to the aorta virtually the same?

- ☐ A the number of red blood cells per millilitre of blood
- ☐ B the blood pressure
- ☐ C the amount of blood per minute
- ☐ D the blood's carbon dioxide level

- c** In which blood vessels does the blood have almost the same composition as in the renal artery (renal = of the kidney)?

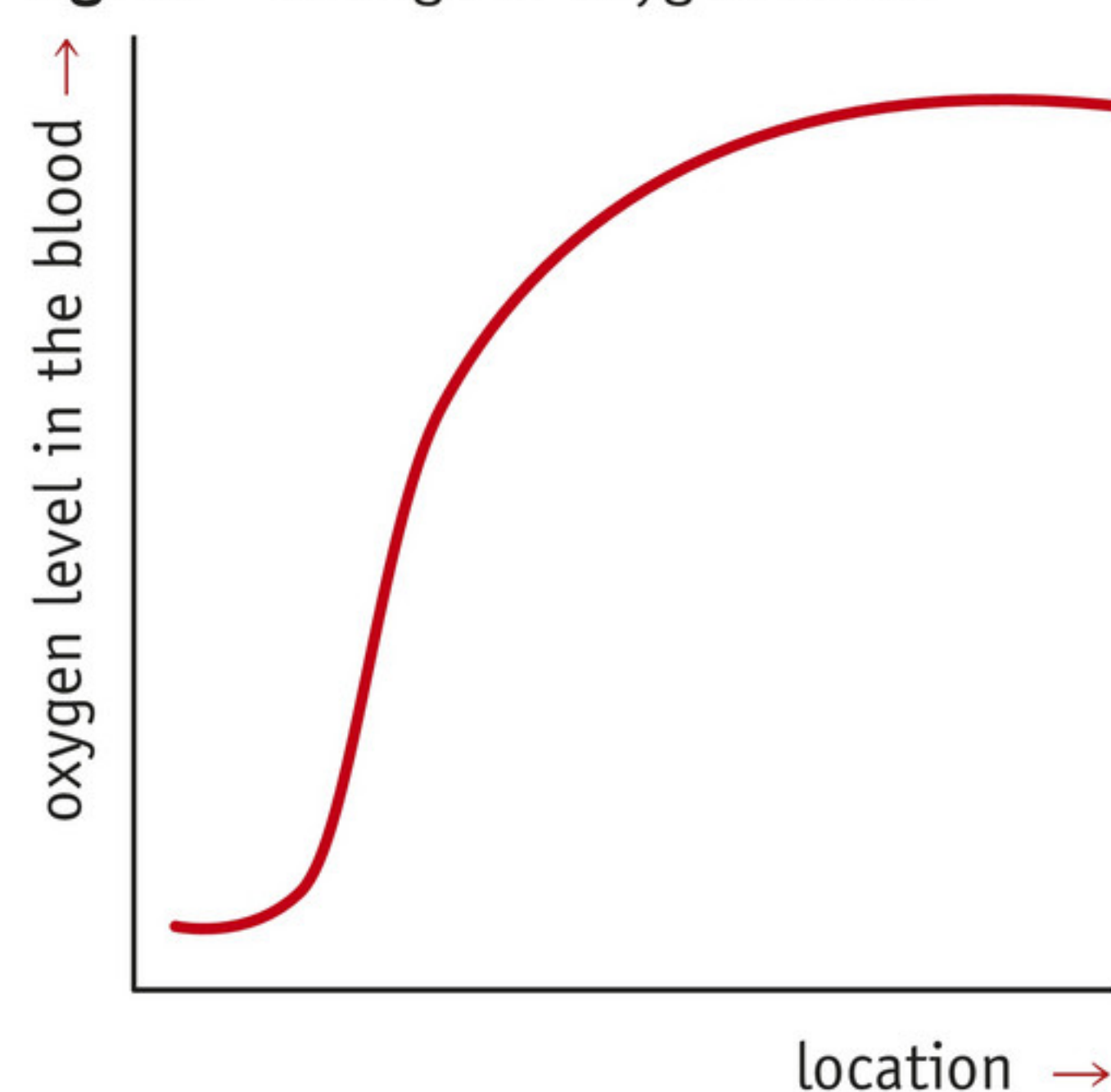
- ☐ A the mesenteric vein (mesenteric = of the intestines)
- ☐ B the mesenteric artery
- ☐ C the hepatic vein (hepatic = of the liver)
- ☐ D the hepatic artery
- ☐ E the pulmonary vein
- ☐ F the pulmonary artery
- ☐ G the renal vein
- ☐ H the portal vein

7

Figure 11 is a diagram of the oxygen content of the blood in part of the double circulation.

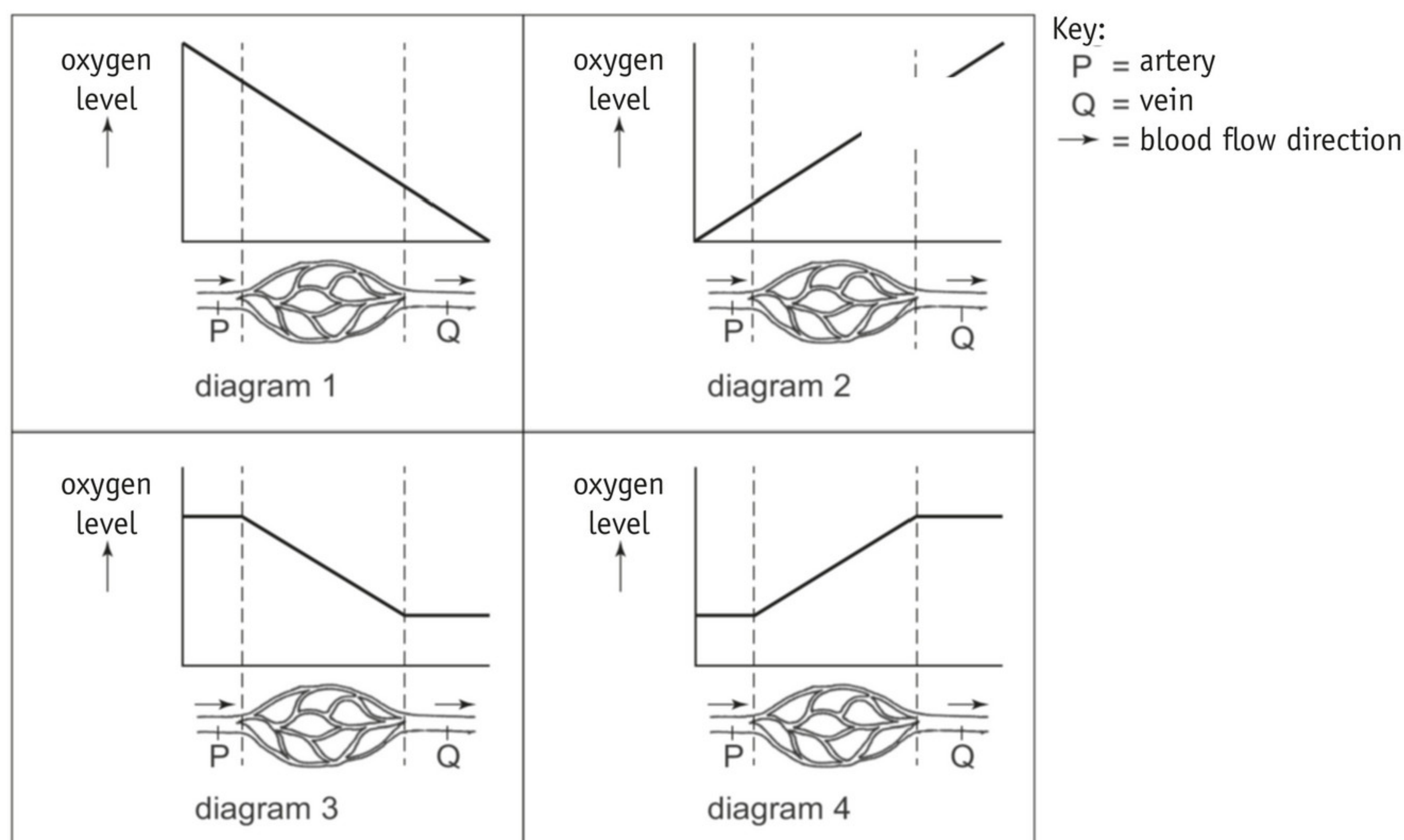
- a** Was the oxygen level being measured in the pulmonary or the systemic circulation? Explain your answer.

fig. 11 Change in oxygen level.



- b** Figure 12 shows four diagrams of the oxygen level of the blood around an organ.
- Which diagram shows the oxygen level in the systemic circulation?
diagram 1 / 2 / 3 / 4
 - Which diagram corresponds to the oxygen level in the pulmonary circulation??
diagram 1 / 2 / 3 / 4

fig. 12 Oxygen level in and around an organ.

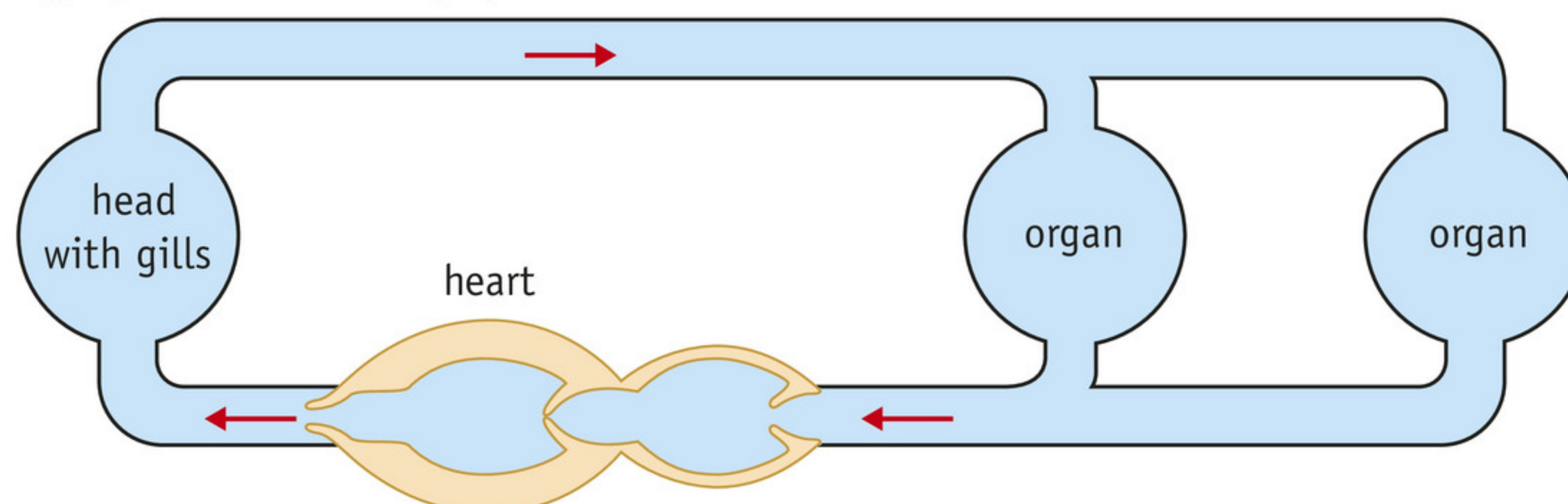


8

Figure 13 is a schematic drawing of the circulation of a fish.

- a** Does a fish have a double circulatory system? Explain your answer.
- b** Humans have a double circulatory system. The heart muscle tissue contains capillaries. Are those capillaries in the human circulatory system part of the systemic circulation, the pulmonary circulation, or both? Explain your answer.
- c** Fish speed up their circulation with their body movements. Explain why this is needed.

fig. 13 The circulatory system of a fish.



9

A patient takes medication for their kidneys. The active substance is absorbed into the blood via the intestinal wall.

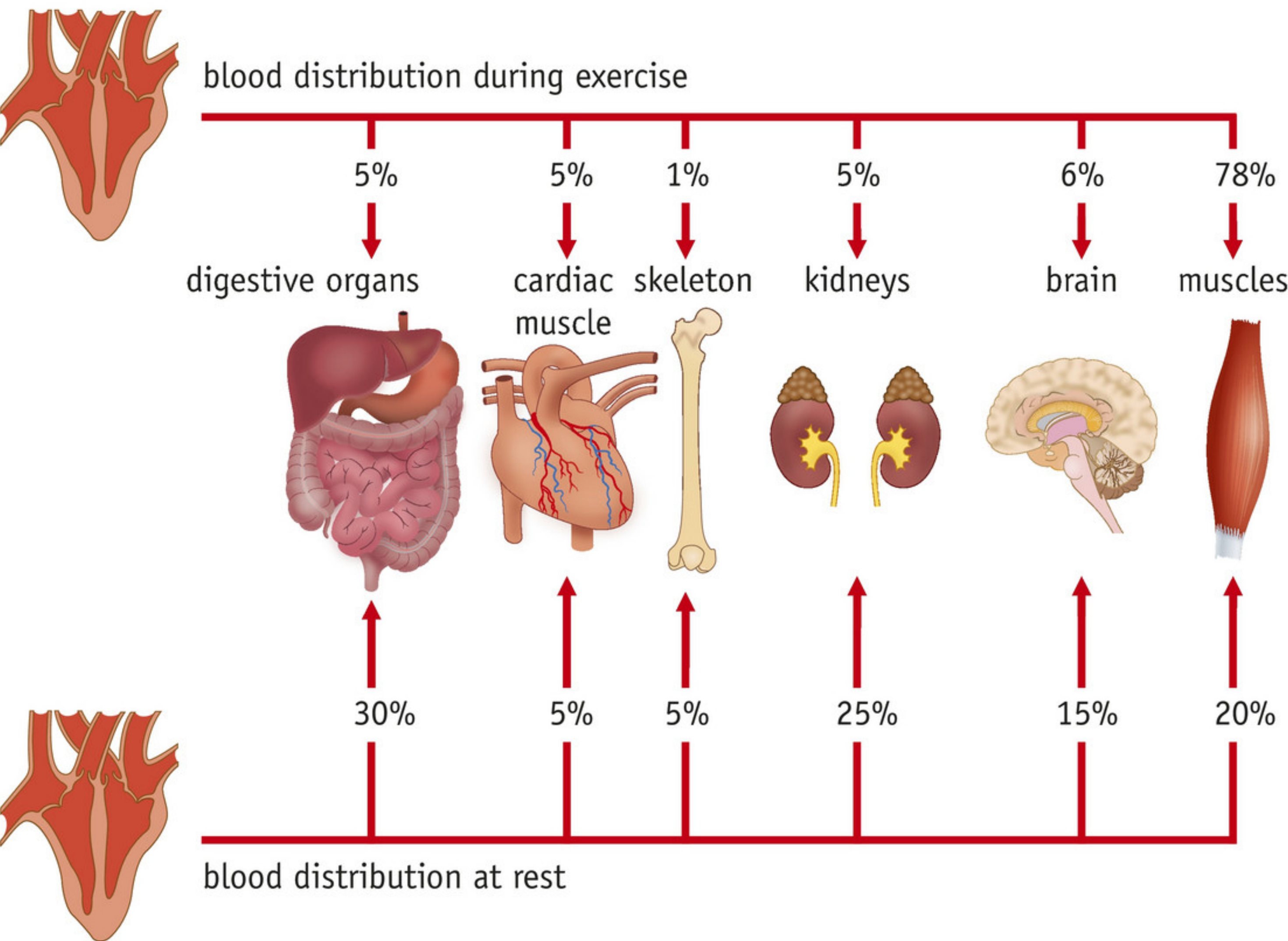
- a** Are these statements correct or incorrect?
- The full amount of the active substance reaches the liver. *correct / incorrect*
 - The full amount of the active substance reaches the kidneys. *correct / incorrect*
 - The medication reaches the lungs before it reaches the kidneys. *correct / incorrect*
- b** Ticks bite into your skin and suck up blood. This creates an opportunity for the bacterium *Borrelia burgdorferi* to get into the bloodstream. This bacterium causes Lyme disease.
- If a tick transmits the bacterium during a bite to the ankle, what route does the bacterium take to end up in the liver?

- aorta
- femoral vein
- 1 capillaries in the ankle
- the heart (first time)
- the heart (second time)
- hepatic artery
- pulmonary vein
- pulmonary capillaries
- pulmonary artery
- inferior vena cava

+ 10

At rest, less blood flows to the muscles than during physical effort (see figure 14). What type of vessel controls how much blood goes to the various organs? Explain your answer.

fig. 14 Blood distribution at rest and during physical effort.



HOW IT FITS TOGETHER science

ARTIFICIAL BLOOD VESSELS FROM THE BODY'S OWN CELLS

Malfunctioning blood vessels are a major cause of disease and premature death. In operations where a vessel is replaced, surgeons prefer to use a piece of the patient's own blood vessels. But that stock is quickly exhausted and not always suitable. That is why surgeons also use artificial blood vessels (see figure 15). In the beginning, some seventy years ago, these were made of nylon shirts, parachutes and women's underwear. Nowadays, materials such as Dacron, Teflon (PTFE) and PET are used. These plastics stretch less and last much longer. However, they sometimes cause infections and blood clots, often at the transition between the natural and artificial blood vessels.

A solution seems to have been discovered in 2019. Scientists managed to produce artificial blood vessels from the patient's own cells. Collagen tubes are made in the laboratory. Blood vessel cells from deceased donors are used for this. These collagen tubes are inserted into the patient. The patient's own blood vessel wall cells then become embedded in the collagen. This creates blood vessel tissue that is the body's own, while the donor collagen disappears. After a few weeks, properly functioning blood vessels have been formed that are not rejected by the patient's body.

Sources: *de Volkskrant*, 'De slangen en buizen van de vaatkloster', Maarten Evenblij, 8 February 1997; NRC, 'Mensencellen bouwen kunstbloedvat', Wim Köhler, 29 March 2019.

fig. 15 Artificial blood vessels.



11

Read the text 'Artificial vessels from the body's own cells'.

- a** In the beginning, nylon stockings were used to make artificial blood vessels. In the body, this porous, woven material was naturally covered with a blood-tight layer after a few minutes thanks to the effect of platelets. Explain how this layer is formed on the nylon.
- b** Which two types of vessels make sure that the cells in the organs get enough oxygen and nutrients?
- c** Why is it so difficult to mimic blood vessels properly with the new method (using the patient's own cells)? Your answer should explain it using the properties of the three types of blood vessels.
- d** The basis of the newly grown blood vessels is collagen (which is like a glue). What other tissue contains a lot of collagen?

 Go to the *Flash cards* and the *Test yourself* section.

3 The heart

LEARNING OBJECTIVES

- 3.3.5 You can name the parts of the heart with their features and functions and the blood vessels they are connected to.
- 3.3.6 You can describe the progress of a heartbeat.

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES			
	3.3.5	3.3.6	3.2.3*	3.2.4*
Remembering	1			
Understanding	2, 4	3, 4		
Using	5abcd, 8bcd, 9a, 11ab	5abcd, 8abd, 11a		8bc
Analysing	5e, 6, 7, 9b, 10a, 11cd	5e, 6, 11c	7, 10ab	

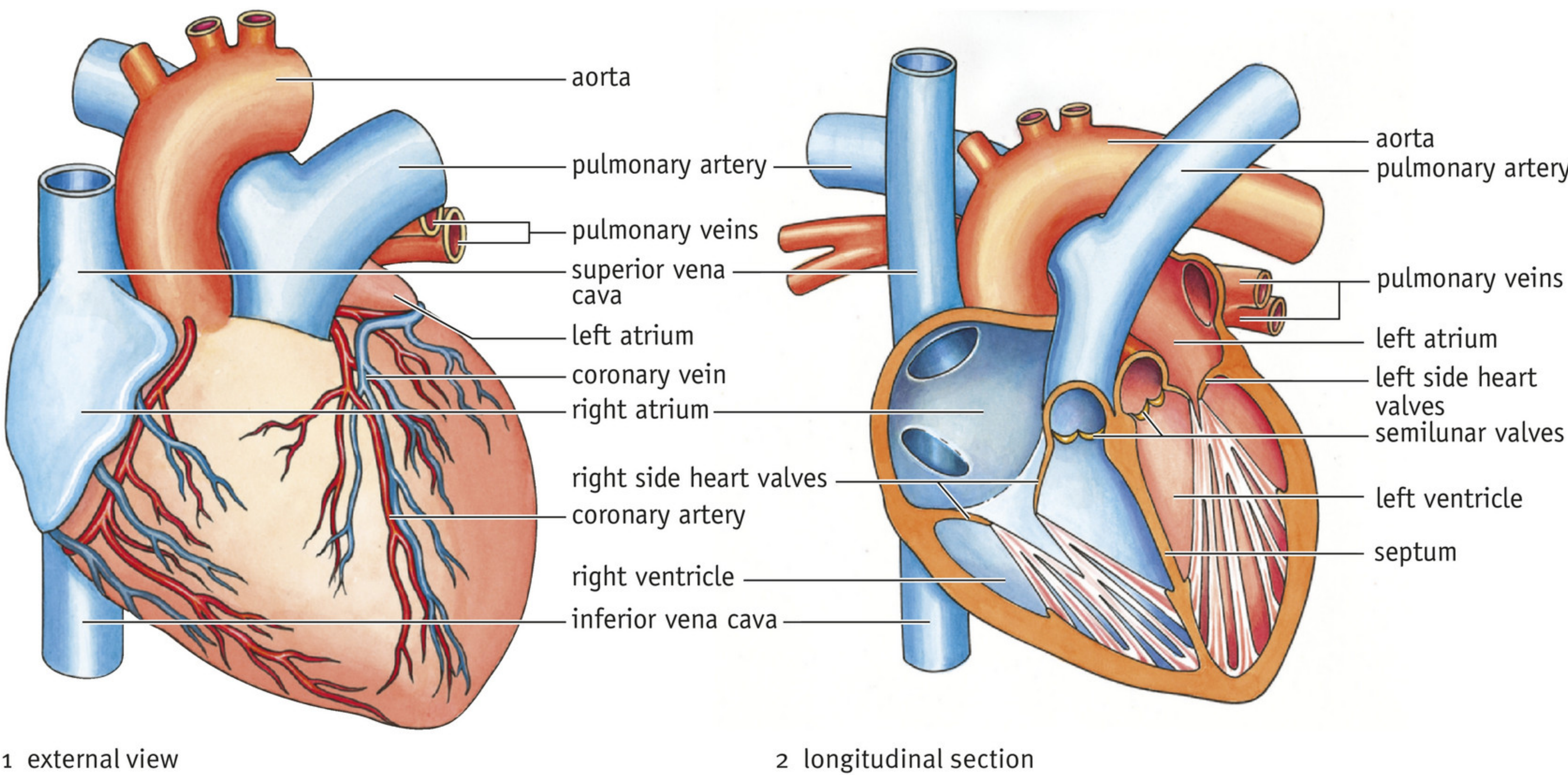
* You can find this learning objective in another Basics section.

The heart is inside the chest cavity, slightly to the left below the sternum. Your heart is about the size of your fist. On average, the heart muscle contracts seventy times a minute.

THE STRUCTURE OF THE HEART

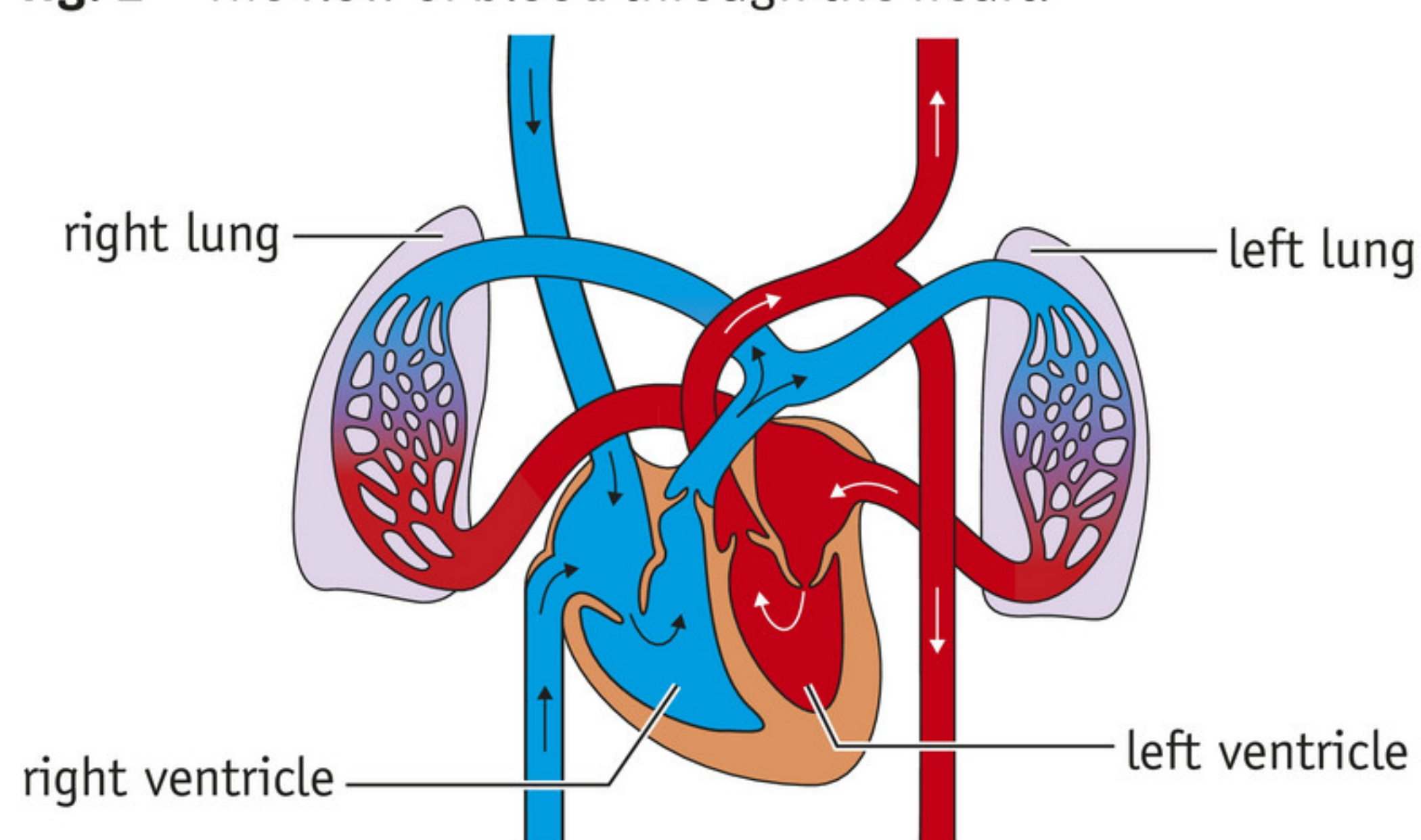
The heart is a hollow muscle. Coronary arteries and coronary veins run across the outside of the heart (see figure 1.1). The **coronary arteries** supply blood that is rich in oxygen and nutrients to the heart muscle. The coronary arteries branch off from the aorta. The **coronary veins** carry blood that is rich in carbon dioxide and other waste products away from the heart muscle. The coronary veins exit into the right atrium. The heart consists of two atria and two ventricles (see figure 1.2). The **cardiac septum** is a wall separating the left and right sides of the heart.

fig. 1 The heart



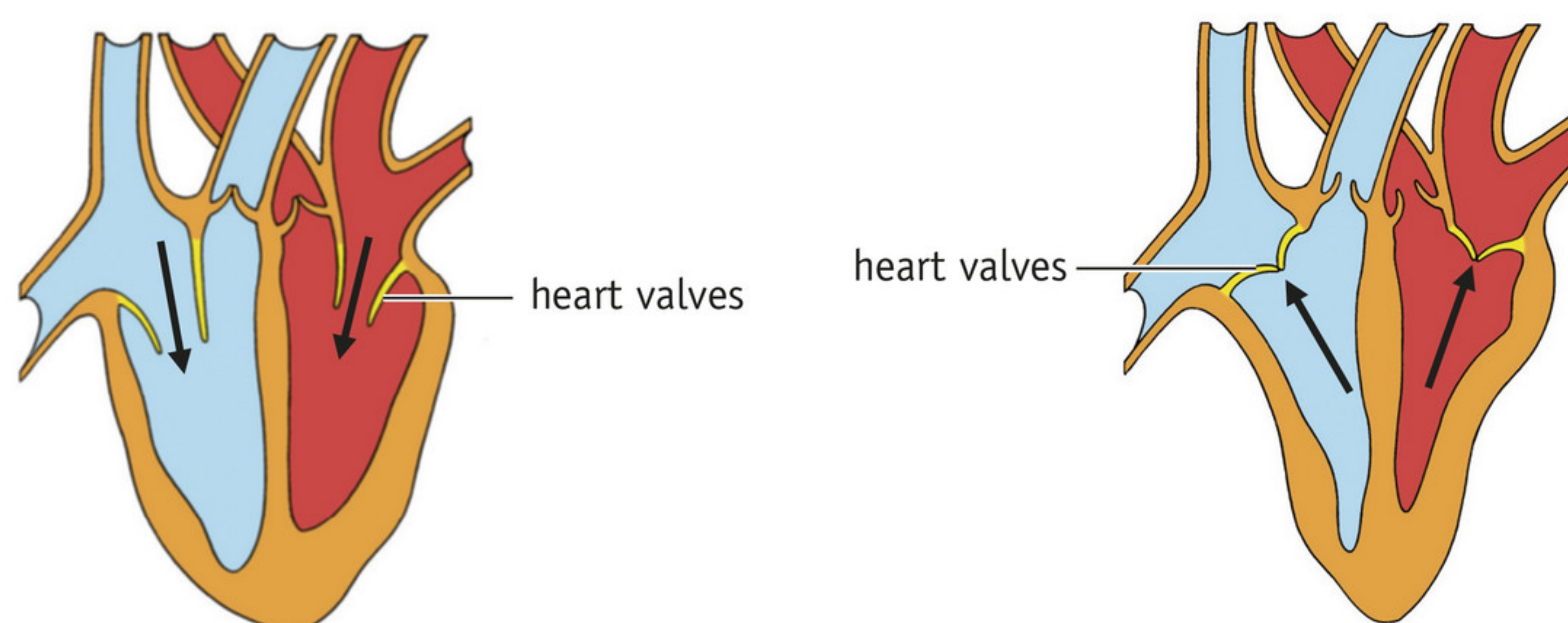
From the organs in the head and from the arms, deoxygenated blood enters the heart through the **superior vena cava** (see figure 2). Blood that is low in oxygen enters the heart through the **inferior vena cava** from the organs in the body and from the legs. Both the superior and inferior vena cava and the coronary veins exit into the **right atrium**. From the right atrium, deoxygenated blood flows to the right ventricle. The **right ventricle** pumps the blood into the **pulmonary arteries**. The blood is oxygenated in the lungs and flows back to the heart through the **pulmonary veins**. Blood from the pulmonary veins flows into the **left atrium**. From the left atrium, oxygen-rich blood flows to the left ventricle. The **left ventricle** pumps the blood through the **aorta** to all the body's organs where it becomes deoxygenated. The deoxygenated blood flows back to the heart through the inferior and superior vena cava.

fig. 2 The flow of blood through the heart.



An atrium and a ventricle are separated by **heart valves**. These prevent the blood from flowing back from the ventricles into the atria (see figure 3).

fig. 3 How the heart valves work.

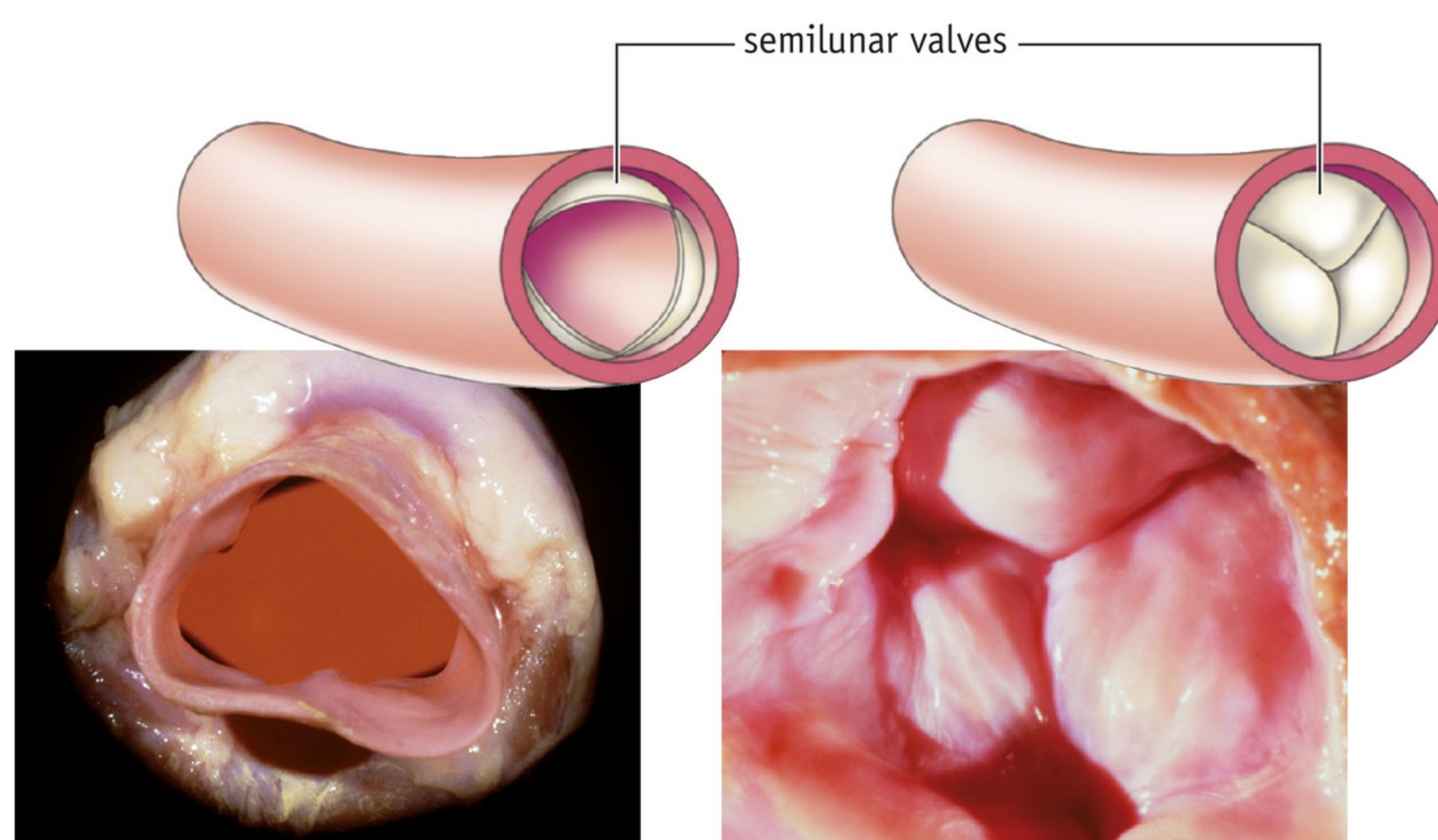


1 heart valves are open: blood flows from the atria to the ventricles

2 heart valves are closed: blood cannot flow back from the ventricles into the atria

The **semilunar valves** are at the entrances to the pulmonary artery and aorta (see figure 4). They prevent the blood from flowing back into the atria. When the semilunar valves are open, the blood can flow from the right ventricle into the pulmonary artery and from the left ventricle into the aorta (see figure 5.1). When the semilunar valves are closed, the blood cannot flow back from the pulmonary artery to the right ventricle or from the aorta to the left ventricle (see figure 5.2).

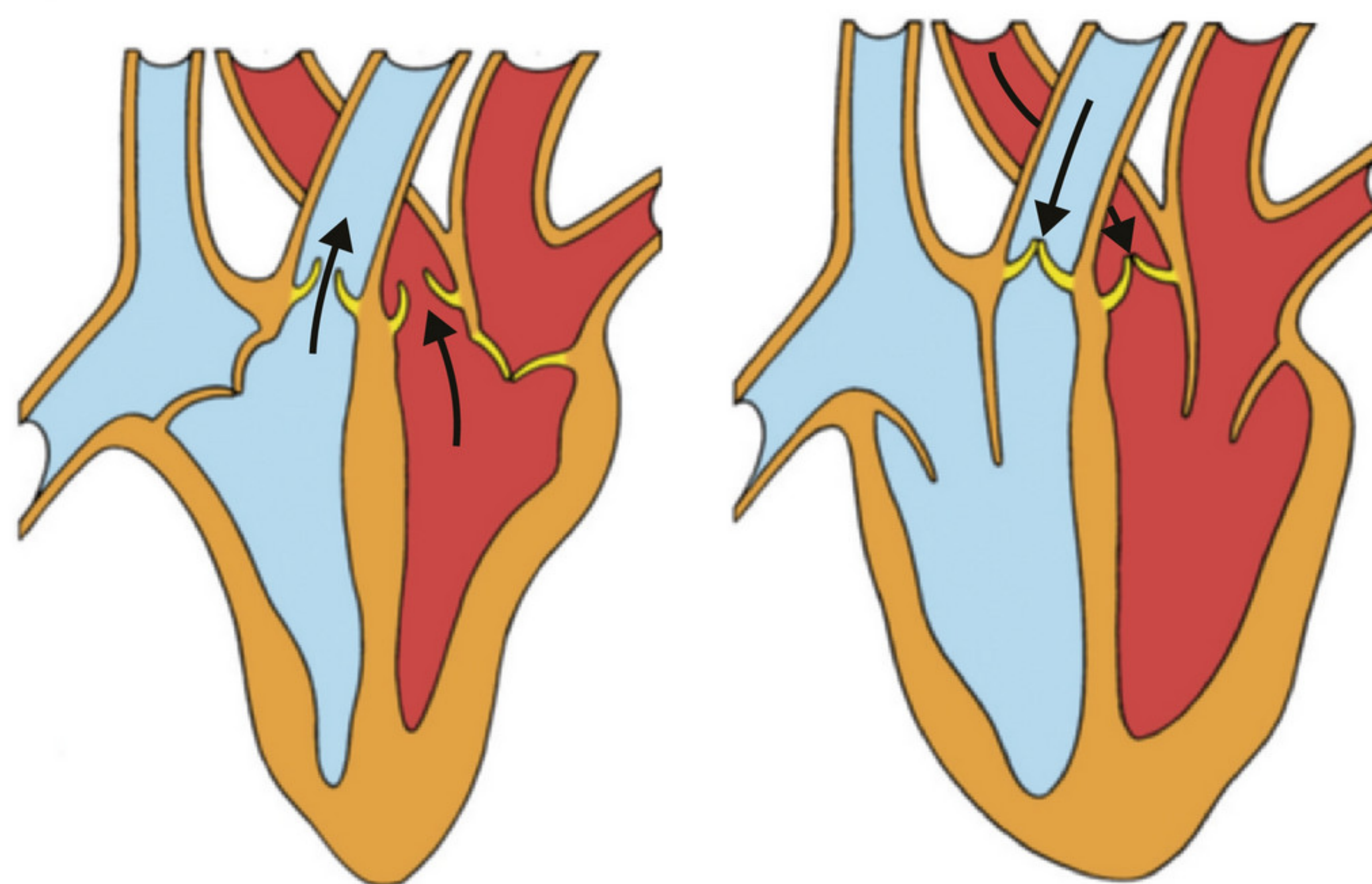
fig. 4 Semilunar valves in the aorta.



1 semilunar valves open

2 semilunar valves open

fig. 5 How the semilunar valves work.



1 semilunar valves open: blood can flow from the right ventricle into the pulmonary arteries and from the left ventricle into the aorta

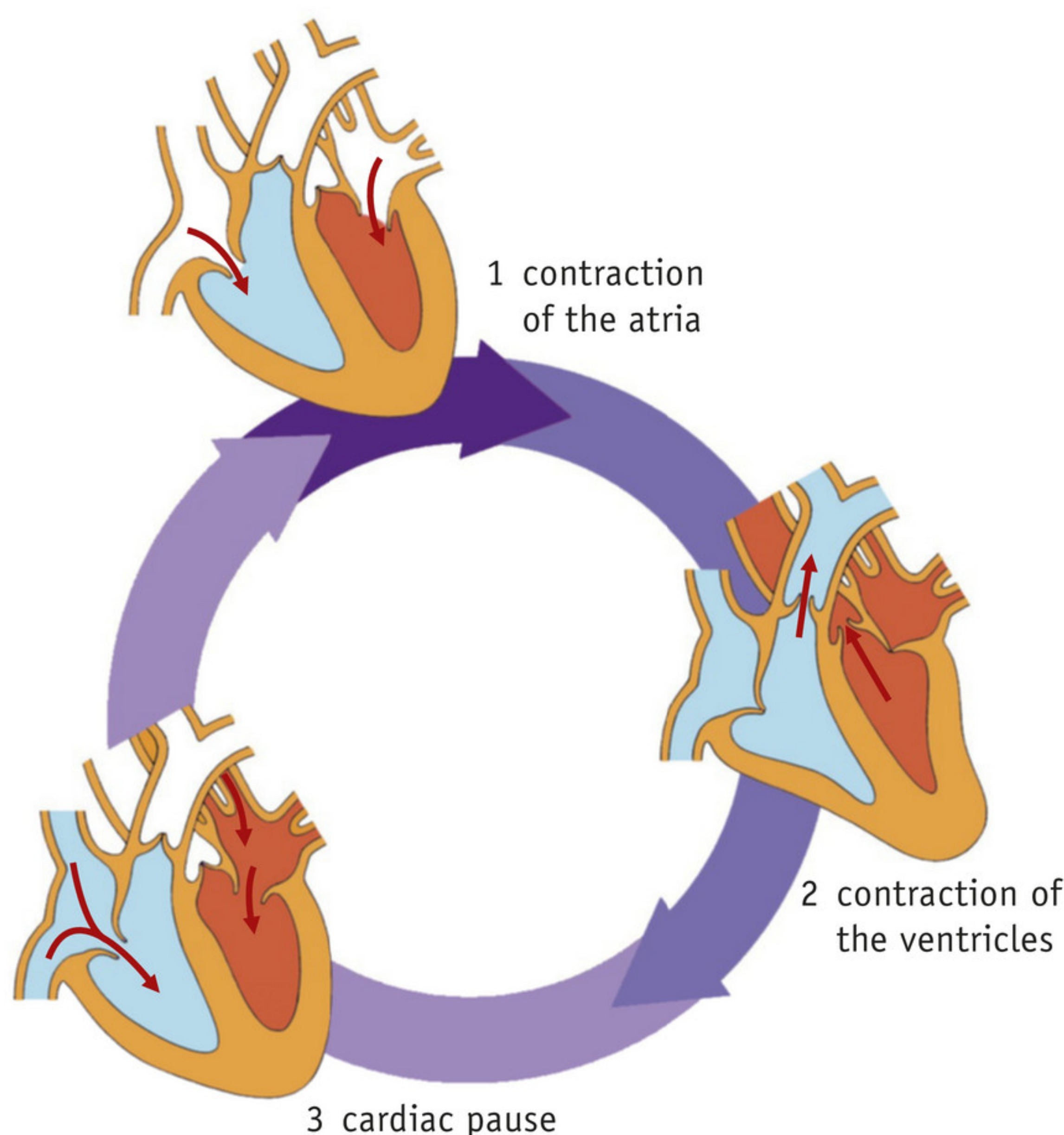
2 semilunar valves closed: blood cannot flow back from the pulmonary arteries to the right ventricle or from the aorta to the left ventricle

THE CARDIAC CYCLE

On average, an adult's heart muscle contracts seventy times a minute. That is what we call 'a heart rate of 70'. The **heartbeat** can be heard because closing the valves creates a sound. The way the heart works is made up of three phases (see figure 6):

- 1 The heartbeat starts with contraction of the atria, which filled with blood just before. Both atria contract at the same time. This makes blood flow into the ventricles (see figure 6.1). The ventricles are relaxed.
- 2 Once the ventricles are filled with blood, they contract (see figure 6.2). The heart valves close and prevent the blood from flowing back into the atria. The pressure in the ventricles increases. Once the pressure in the ventricles is higher than the pressure in the aorta and the pulmonary artery, the semilunar valves are pushed open. Blood is pumped simultaneously into the aorta and the pulmonary artery. During the contraction of the ventricles, the atria are relaxed.
- 3 After this, there is the **cardiac pause**, when both the atria and the ventricles are relaxed. The blood flows from the vena cava and pulmonary veins into the atria, and to some extent into the ventricles too (see figure 6.3). The semilunar valves are closed. This keeps the blood from the pulmonary artery and aorta from flowing back into the ventricles. Then it's phase 1 again.

fig. 6 The three phases of a heartbeat.

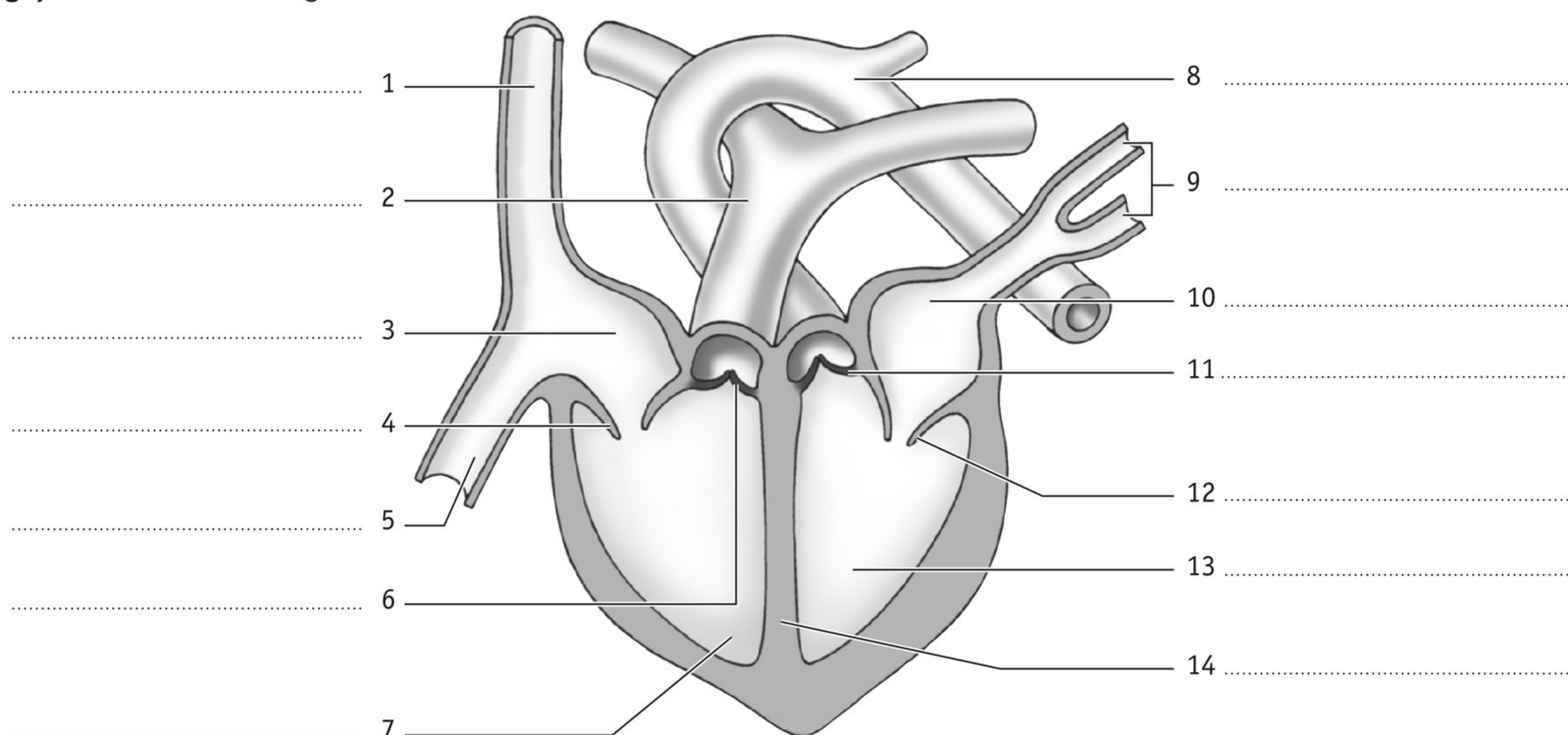


KNOWLEDGE

1

Figure 7 shows a schematic drawing of the heart with blood vessels.

- a Write down the names of the numbered parts.
- b Which blood vessels does oxygen-rich blood flow through to the heart muscle?
through the *coronary veins* / *coronary arteries*
- c Which blood vessels does blood containing waste flow away from the heart muscle through?
through the *coronary veins* / *coronary arteries*

fig. 7 Schematic drawing of the human heart.**2**

- a** A white blood cell from the left femoral vein goes with the bloodstream until it is in the left femoral artery.

Which blood vessels and compartments of the heart does this blood cell pass through, and in what order?

..... aorta
 1 left femoral vein
 11 left femoral artery
 left atrium
 left ventricle
 pulmonary vein
 pulmonary capillaries
 pulmonary artery
 inferior vena cava
 right atrium
 right ventricle

- b** A blood clot from a femoral vein gets into the lungs via the bloodstream.

Which parts of the heart did this clot pass through?

- ☐ A first the left atrium, then the left ventricle
☐ B first the left ventricle, then the left atrium
☐ C first the right atrium, then the right ventricle
☐ D first the right atrium, then the right ventricle

- c** For questions (c) and (d), choose between: *aorta – organ capillaries – vena cava – left atrium – left ventricle – pulmonary veins – pulmonary capillaries – pulmonary arteries – right atrium – right ventricle.*

Write down the blood vessels and parts of the heart in the correct order for the pulmonary circulation.

- d** Write down the blood vessels and parts of the heart in the correct order for the systemic circulation.

3

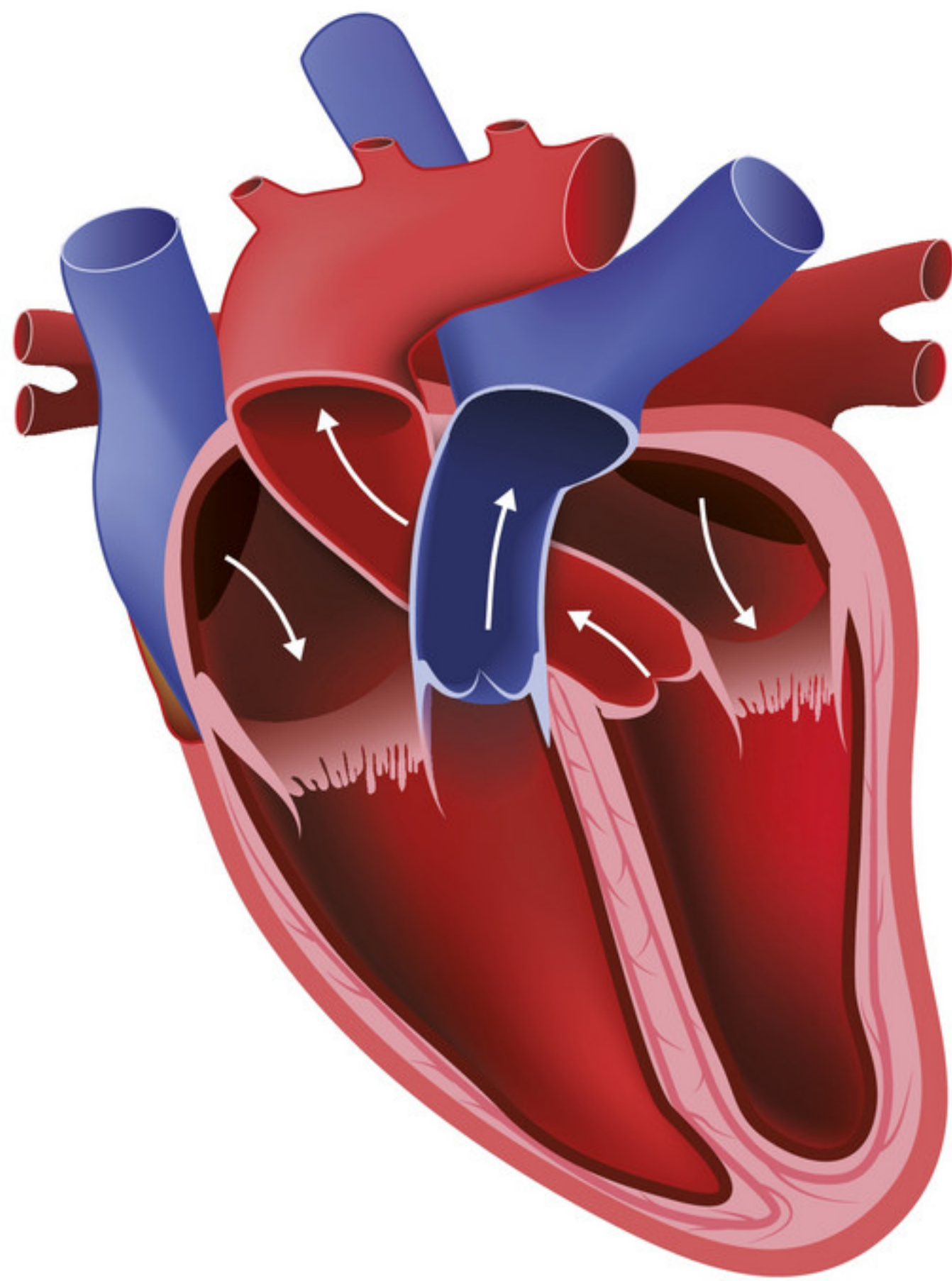
- a** A heartbeat starts with contraction of the atria.
Fill in the missing words. Choose between: *atria – close – closed – venae cavae and pulmonary veins – ventricles – pulmonary artery and aorta – open.*
- The atria contract. This makes blood flow into the
.....
 - At that moment, the heart valves are
At the same time, the semilunar valves are
 - Immediately after that, the contract.
 - The heart valves
The pressure in the increases.
 - The semilunar valves
 - The blood gets pumped into the
 - After this, there is the cardiac pause.
 - At that moment, the heart valves are
At the same time, the semilunar valves are
 - From the, the blood flows into
the and to some extent into
the
- b** The human heart has heart valves and semilunar valves.
Is there a moment during the heartbeat when all the valves are open? *yes / no*

4



Summary
Use figure 8 and the table to create a summary.

fig. 8 A cross-section of the heart.



Parts	Characteristics and functions
Superior and inferior vena cava	
Right atrium	
Right ventricle	
Pulmonary arteries	
Pulmonary veins	
Left atrium	
Left ventricle	
Aorta	
Cardiac septum	
Heart valves	
Semilunar valves	
Coronary arteries	
Coronary veins	

INSIGHT

5

The thickness of the muscular wall of the heart is not the same everywhere. The amount of blood flowing through various organs is also different.

- Is there a difference between the amount of blood that is being pumped out by the right and left ventricles? Explain your answer.
- Which ventricle needs to exert the most force? Explain your answer.
- Which part of the heart has the most muscular wall?
the left atrium / the left ventricle / the right atrium / the right ventricle
- Compare the aorta to the pulmonary artery.
The blood pressure in the aorta is *higher than / the same as / lower than* the blood pressure in the pulmonary artery.
- Which organ (after to the heart) does the greatest amount of blood flow through per minute? Explain your answer.

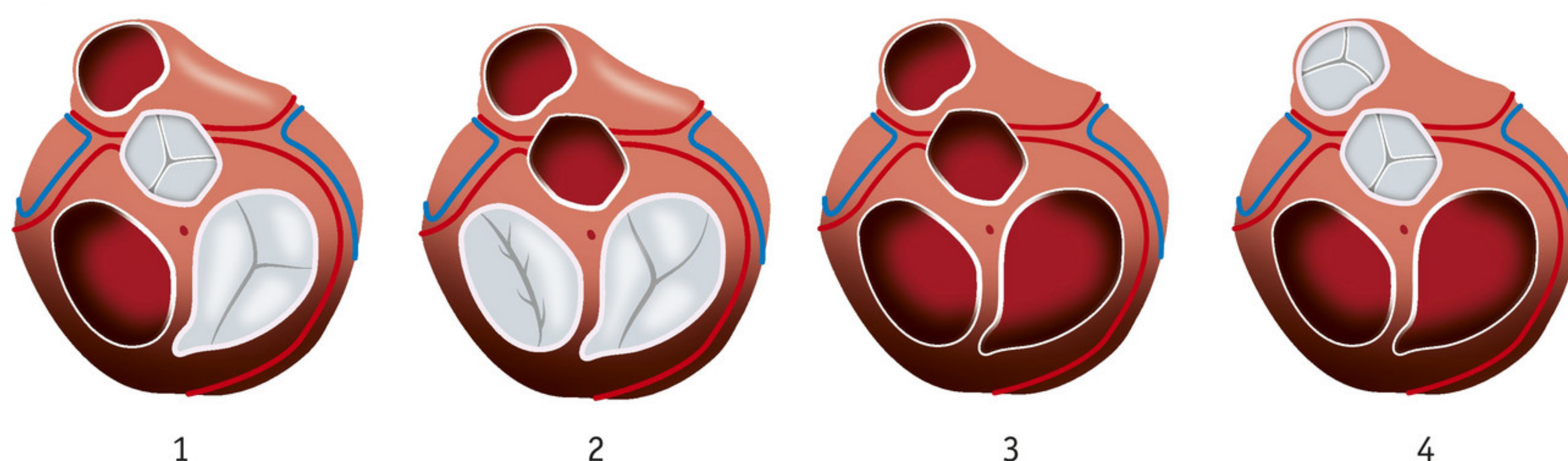
6

Figure 9 shows four cross-sections of the heart. The heart has been prepared so that all the valves are visible. The valves are drawn as open or closed.

In which drawings can you see the valves in positions that occur during a normal heartbeat?

- ☐ A drawing 1
☐ B drawing 2
☐ C drawing 3
☐ D drawing 4

fig. 9 Cross-sections of the heart.



7

A red blood cell is in the inferior vena cava. The cell then passes through the heart six times.

How often has this red blood cell gone through the liver when it leaves the heart for the sixth time?

- at least *0 / 1 / 2 / 3 / 4 / 5 / 6* times
- at most *0 / 1 / 2 / 3 / 4 / 5 / 6* times

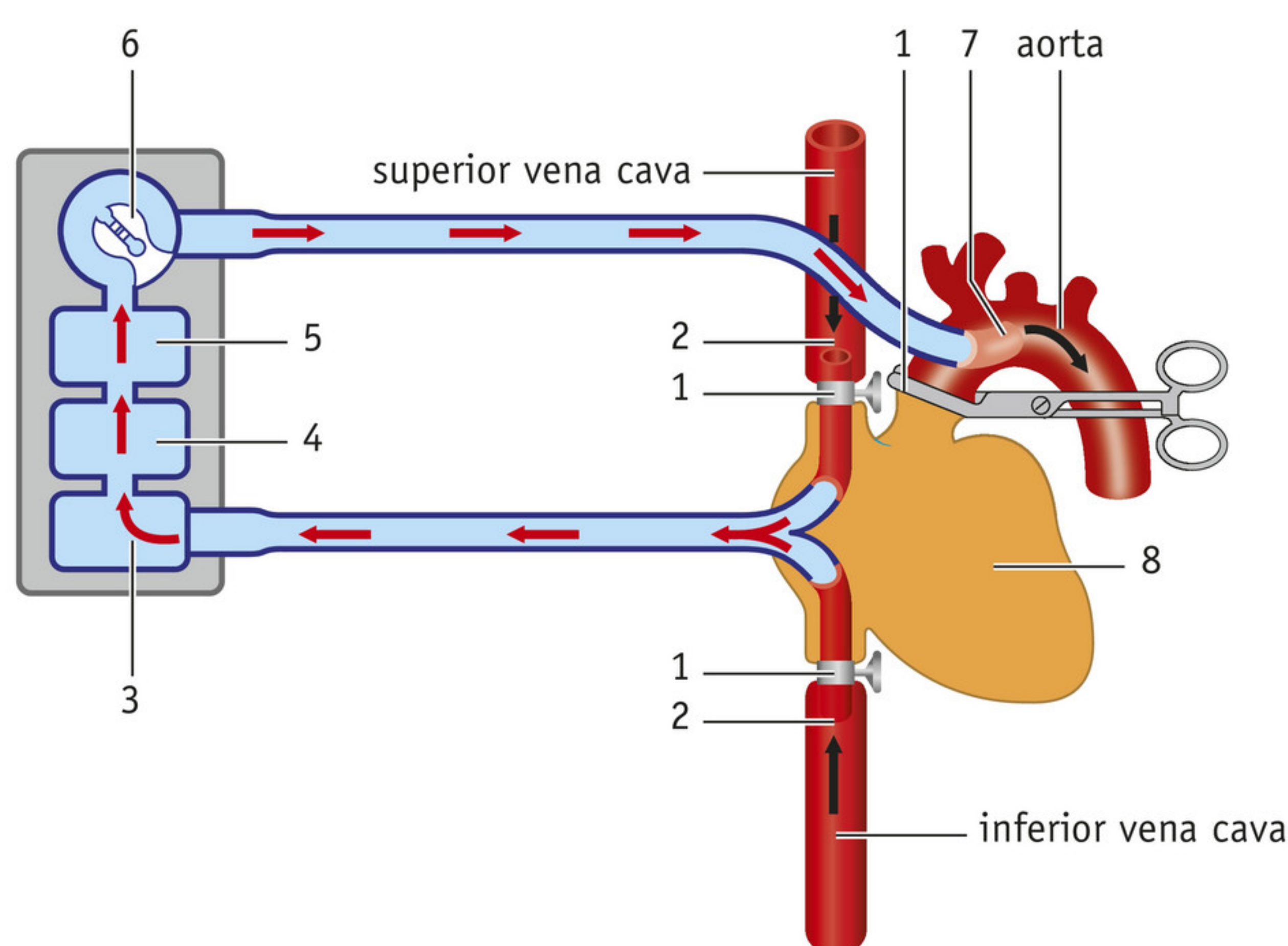
8

The heart has to be stopped in many heart operations. The heart and lung functions are taken over by a heart-lung machine. Figure 10 is a diagram showing how such a machine works.

- Which part of the machine takes over the function of the left ventricle?
part 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8
- Which part of the machine takes over the function of the lungs?
part 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8

- c** During surgery, a patient is connected up to the heart-lung machine. Does the blood then flow through this patient's pulmonary circulation, through their systemic circulation or through both?
- ☐ A only through the systemic circulation
 - ☐ B only through the pulmonary circulation
 - ☐ C through both the systemic and the pulmonary circulation
- d** In an adult, the heart pumps approximately 70 mL of blood per beat. The average heart rate for adults is 70. You can use this data to calculate how much blood a heart pumps per minute, on average. Given: 1 L = 1000 mL.
- On average, how many litres (L) of blood does the pump of a heart-lung machine pump into the aorta? average L

fig. 10 The heart-lung machine.



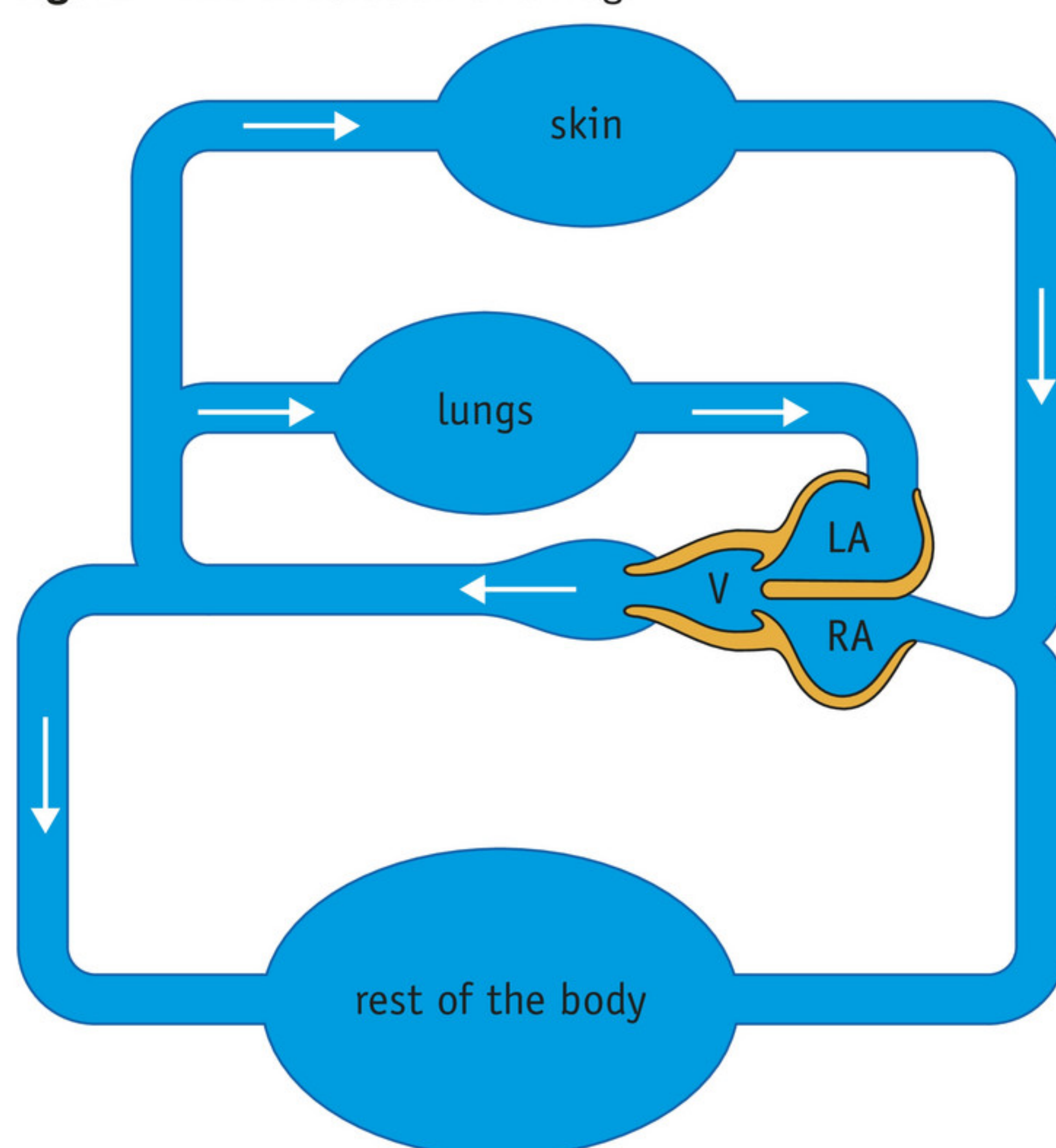
Legend:

- 1 The vena cava and aorta are clamped, so that no blood flows through the heart any more.
- 2 The blood from the vena cava is collected and passed to the heart-lung machine.
- 3 Reservoir for storing blood.
- 4 Part of the heart-lung machine that oxygenates the blood.
- 5 Heat exchanger to cool the blood.
- 6 Pump that sends the blood back to the aorta.
- 7 Blood inlet to the aorta.
- 8 Stopped heart.

+ 9

- a** Figure 11 is a schematic drawing of a frog's circulation. What compartments are there in the heart of a frog?
- b** A frog breathes through its lungs and skin. The blood that has become oxygenated in these organs flows back to the heart. Does the blood in the right atrium of a frog contain more or less oxygen than the blood in the right atrium of a human? Explain your answer.

fig. 11 The circulation of a frog.



+ 10

Two pupils have set up a system to study the flow in the circulatory system (see figure 12). They want to study how the pulsed flow of blood exiting the heart becomes a steady flow of blood through the blood vessels.

a The setup has two valves, numbered 1 and 2.

Which valves in the circulatory system do these valves correspond to?

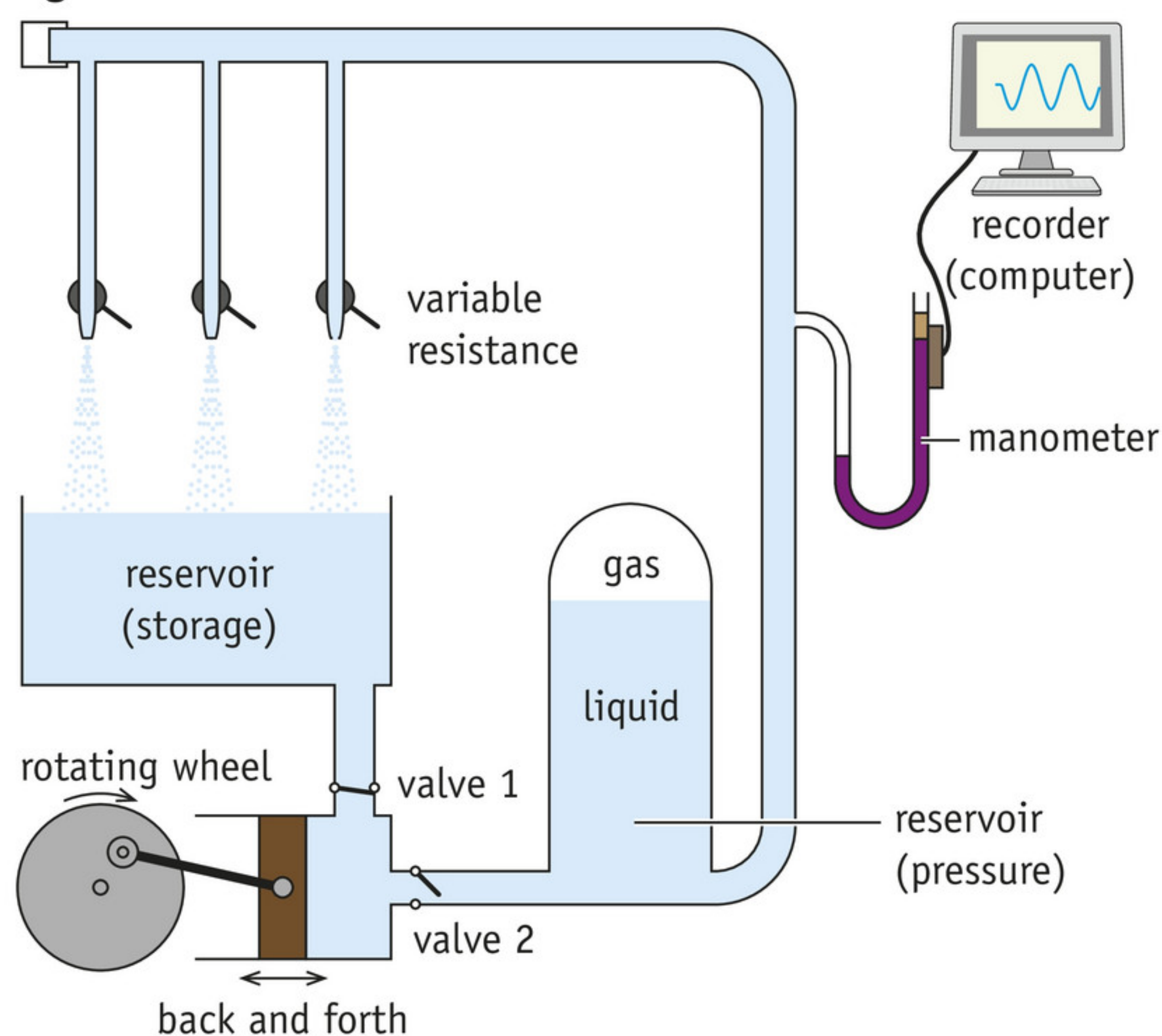
- A valve 1 ☐ ☐ 1 between an atrium and a ventricle
 B valve 2 ☐ ☐ 2 between a ventricle and an artery

b The setup shows a reservoir filled with gas and liquid. The 'heart' pumps blood into this reservoir. Because there is gas there, the volume of the liquid in the reservoir can change, depending on the pressure.

What does the function of this reservoir most closely resemble?

- ☐ A the elasticity of the large arteries
☐ B the volume changes of the capillaries
☐ C blood being stored in the large veins

fig. 12 A model of the blood's circulation.



HOW IT FITS TOGETHER science

HEART DEFECT TECHNOLOGY

Every year, about fifteen hundred children are born with heart defects. Approximately five hundred of these children have an opening in the ventricular septum, the wall separating the ventricles. This defect is relatively easy to detect and treat. More complicated heart abnormalities are a heart with a single ventricle, aortic constriction or Fallot's tetralogy.

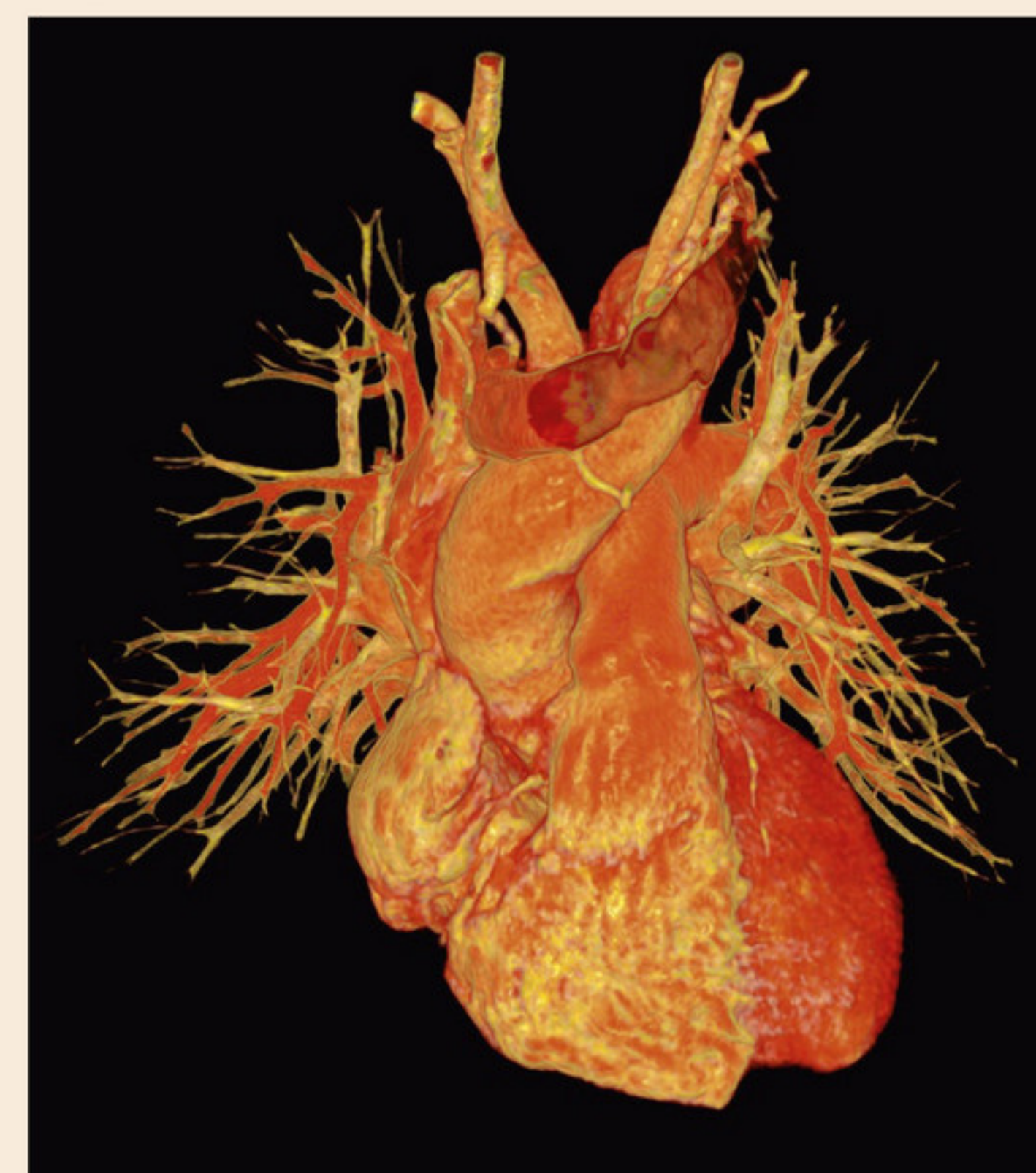
3D and 4D imaging techniques let physicians see a lot. A surgeon explains: "A 2D image of the heart is like a picture of a tree, but a 3D image lets you walk around the tree and see the curved branches from all sides. This technology helps to plan and carry out heart surgery safely.

The next step is 4D, a moving 3D image. This shows the pumping pattern of the heart and the circulation in the vessels. This lets us visualize the turbulence (swirling) of the blood flow and its consequences.

One very important invention is the autonomous surgical robot. This is a tiny robot that independently works its way through the heart, for example searching for a leaking heart valve. This technique reduces the risk of damaging delicate tissue during an operation."

Sources: *de Volkskrant*, 'Operatierobot zoekt zelfstandig zijn weg door kloppend hart', Niels Waarlo, 24 April 2019; *UMC Utrecht*, '4D-techniek laat bloedcirculatie in ader zien', 14 January 2019.

fig. 13 A 3D scan of the heart.



11

Read the text 'Heart defect technology'.

Joshua was born with an abnormality of the heart. He has a 'hole in the heart' – an opening in the ventricular septum. When the ventricles contract, some blood flows through the opening to the right side of the heart.

- a** Does Joshua have more or less blood flowing in the aorta than someone without this defect? Explain your answer.
- b** Does the hole in the ventricular septum affect the oxygen supply to the organs in the body? Explain your answer.
- c** Michelle was born with Fallot's tetralogy. In this cardiac defect, the aorta is shifted above the wall between the heart ventricles and connected to both the left and right ventricles as a result.
Explain why Michelle's heart is less effective than a healthy heart.
- d** Each year, almost four thousand people in the Netherlands get a new heart valve. Which of the four heart valves does a defect in cause most problems for the patient or put them in the most danger? Explain your answer.

 Go to the *Flash cards* and the *Test yourself* section.

4 Excretion

LEARNING OBJECTIVE

3.4.7 You can name the parts of the kidneys and urinary tracts with their features and functions.

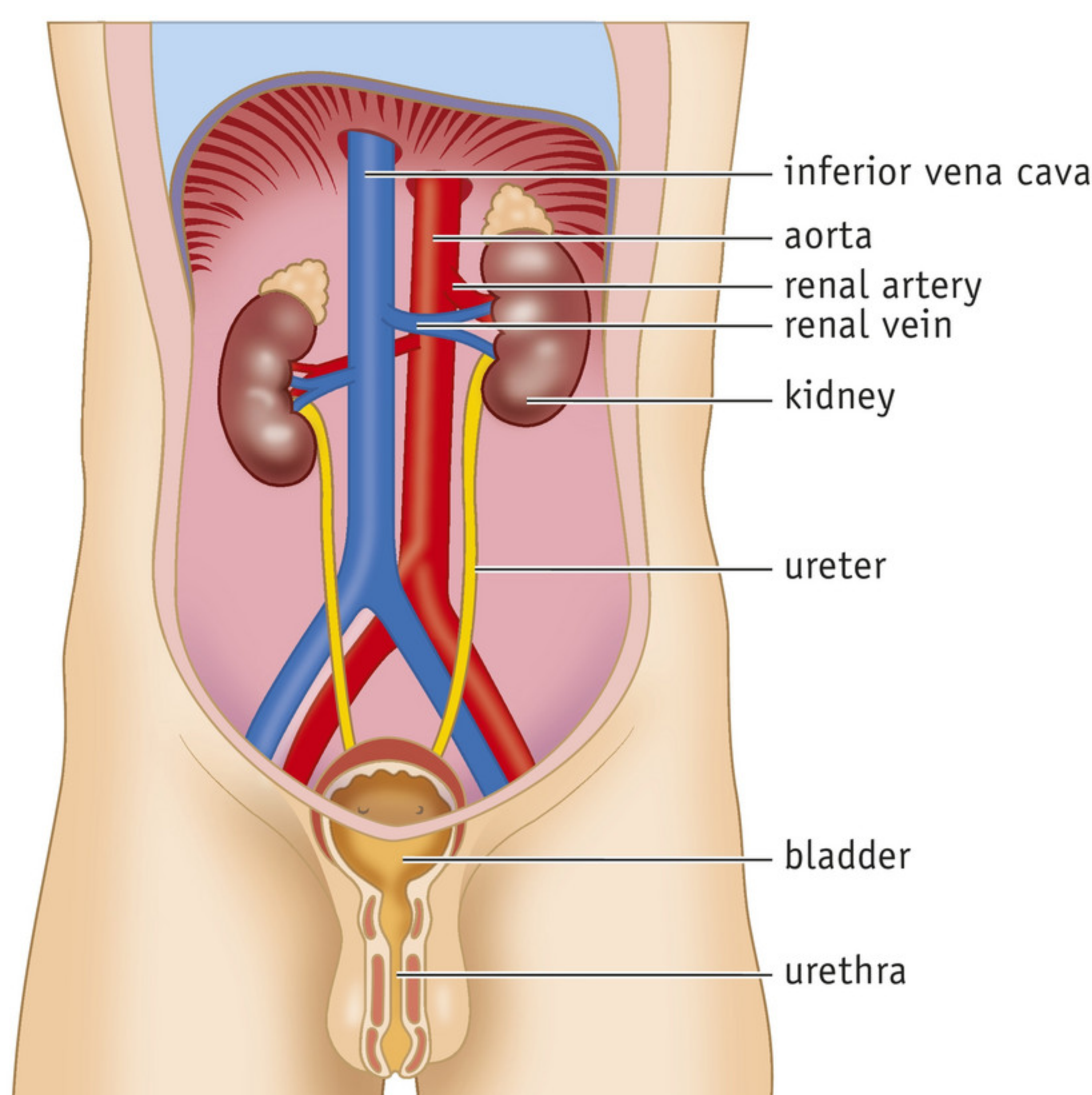
TAXONOMY	LEARNING OBJECTIVE AND EXERCISES
	3.4.7
Remembering	1abcd, 2ab
Understanding	1e, 2c, 3, 4
Using	5, 6, 7a, 9bc
Analysing	7b, 8, 9ad

Excretion takes place in special organs. Carbon dioxide is excreted by the lungs. Most other waste products are excreted via the kidneys.

KIDNEYS AND URINARY TRACT

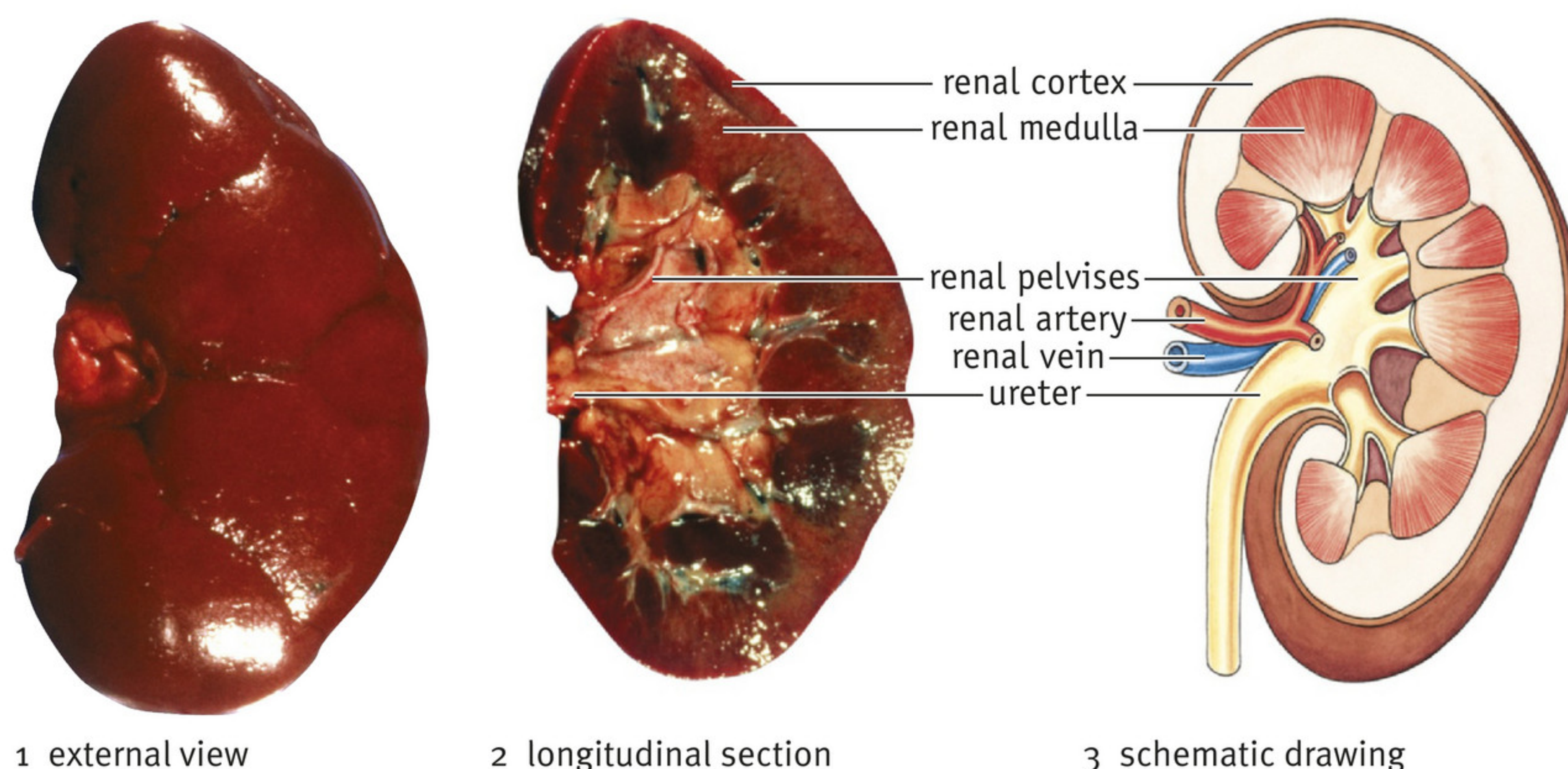
The **kidneys** are in the abdomen to the left and right of the spine, just below the diaphragm (see figure 1). Oxygen-rich blood flows through the **renal arteries** to the kidneys. This blood contains waste products from many organs. The kidneys extract the waste products from the blood. This purified blood flows out of the kidneys through the **renal veins**.

fig. 1 The kidneys and urinary tract.



A kidney consists of the **renal cortex**, **renal medulla** and the **renal pelvis** (see figure 2). The renal cortex and renal medulla remove not only waste products from the blood but also excess water, salts and all kinds of harmful substances. The eliminated substances together are called **urine**.

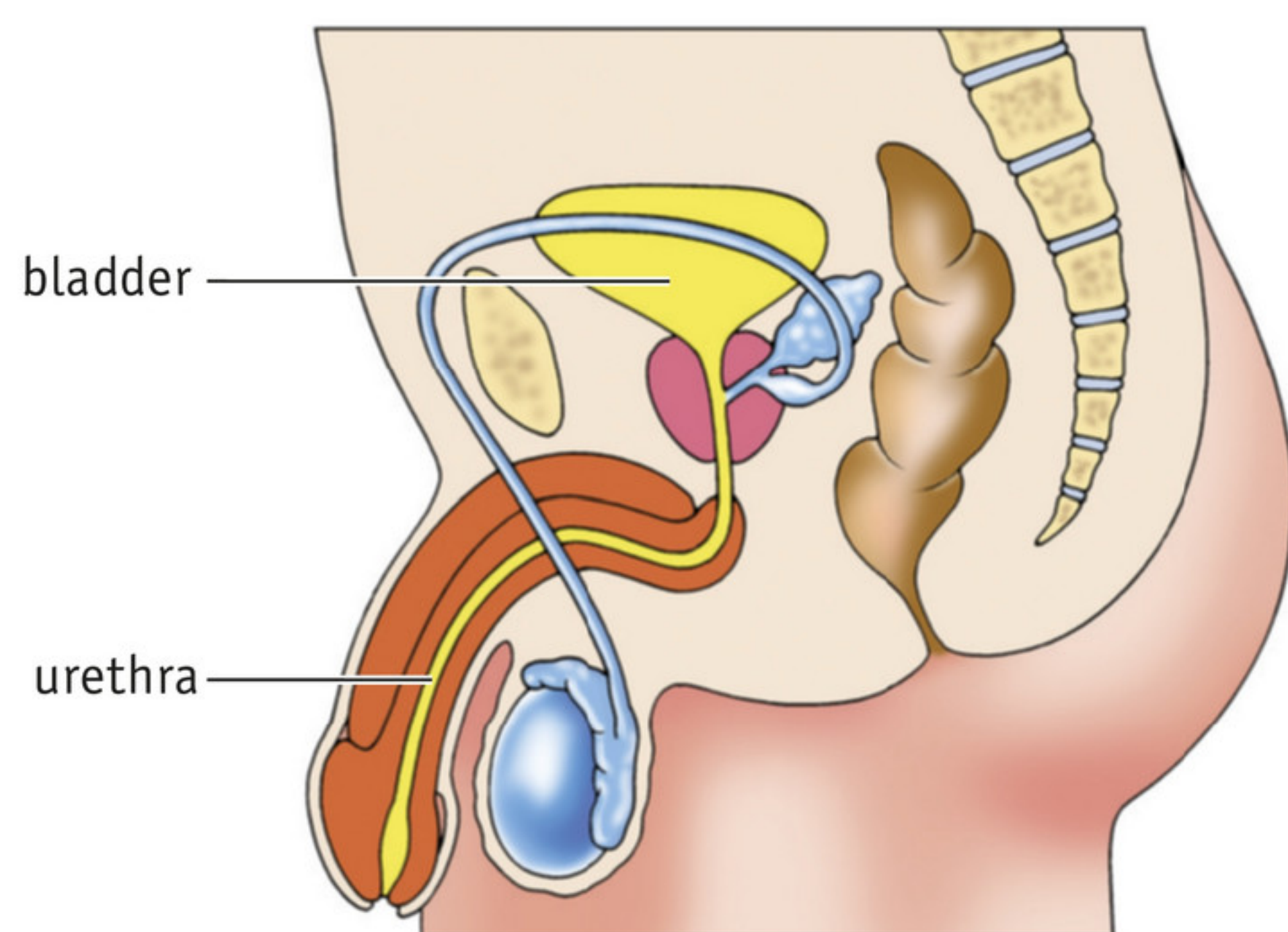
Urine is collected in the renal pelvises, The urine is then sent to the **bladder** via the **ureters** (see figure 3). Urine is stored temporarily in the bladder so that you do not have to urinate all the time. Every now and then, urine is disposed of from the bladder through the **urethra**.

fig. 2 Human kidney.

1 external view

2 longitudinal section

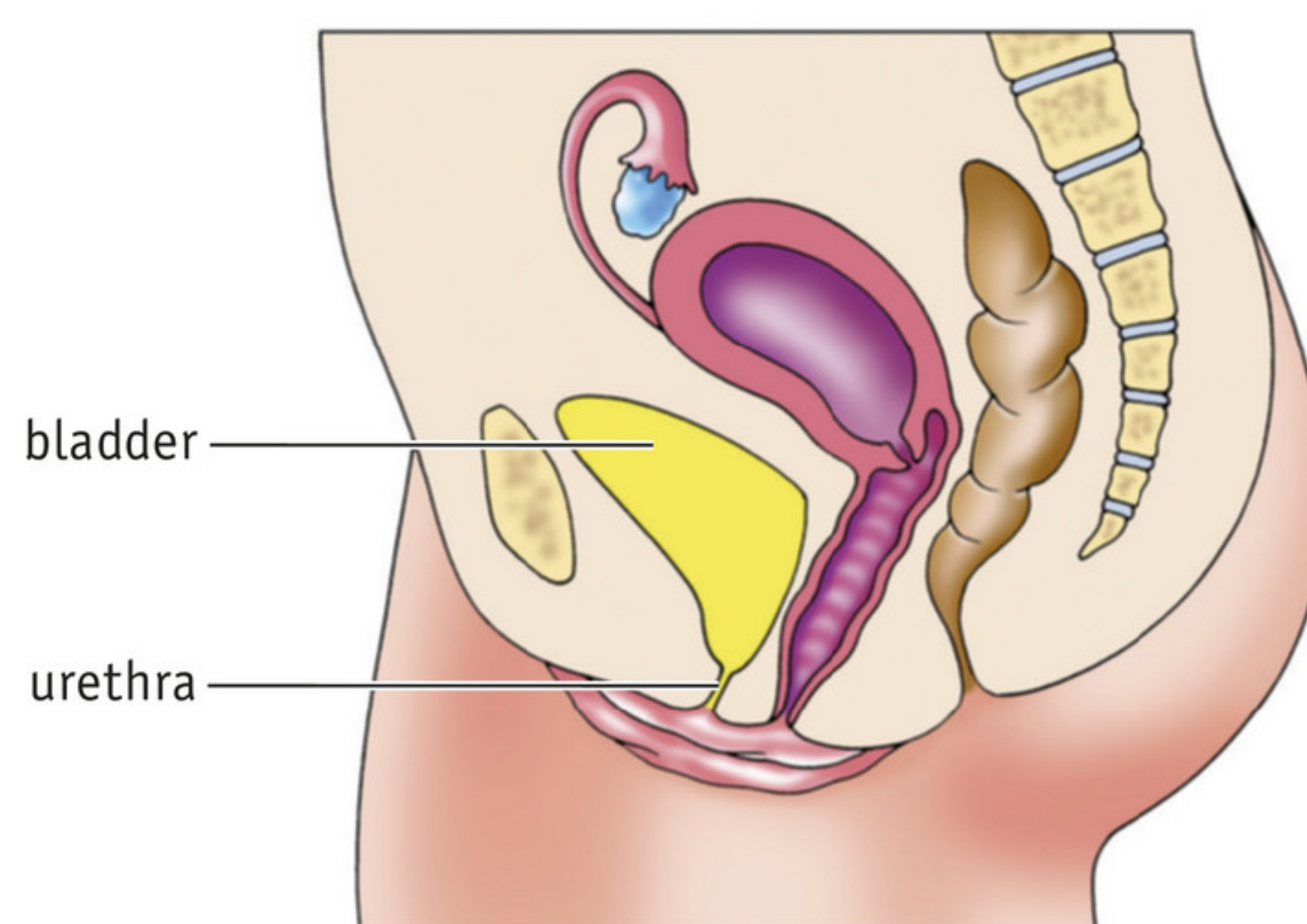
3 schematic drawing

fig. 3 The position of the urinary bladder and ureter.

bladder

urethra

1 in men



bladder

urethra

2 in women

KNOWLEDGE**1**

The kidneys are at the left and right in the abdominal cavity.

- What is the function of the kidneys?
- What does urine consist of?
- Which parts of the kidneys produce urine? *renal pelvis / renal medulla / renal cortex*
- In which part of a kidney is the urine collected? *renal pelvis / renal medulla / renal cortex*
- In a kidney infection, the wall of the renal pelvis is inflamed. This can be caused by bacteria that have entered the body through the urinary tract from outside. Which four parts have these bacteria gone through (in sequence)?

2

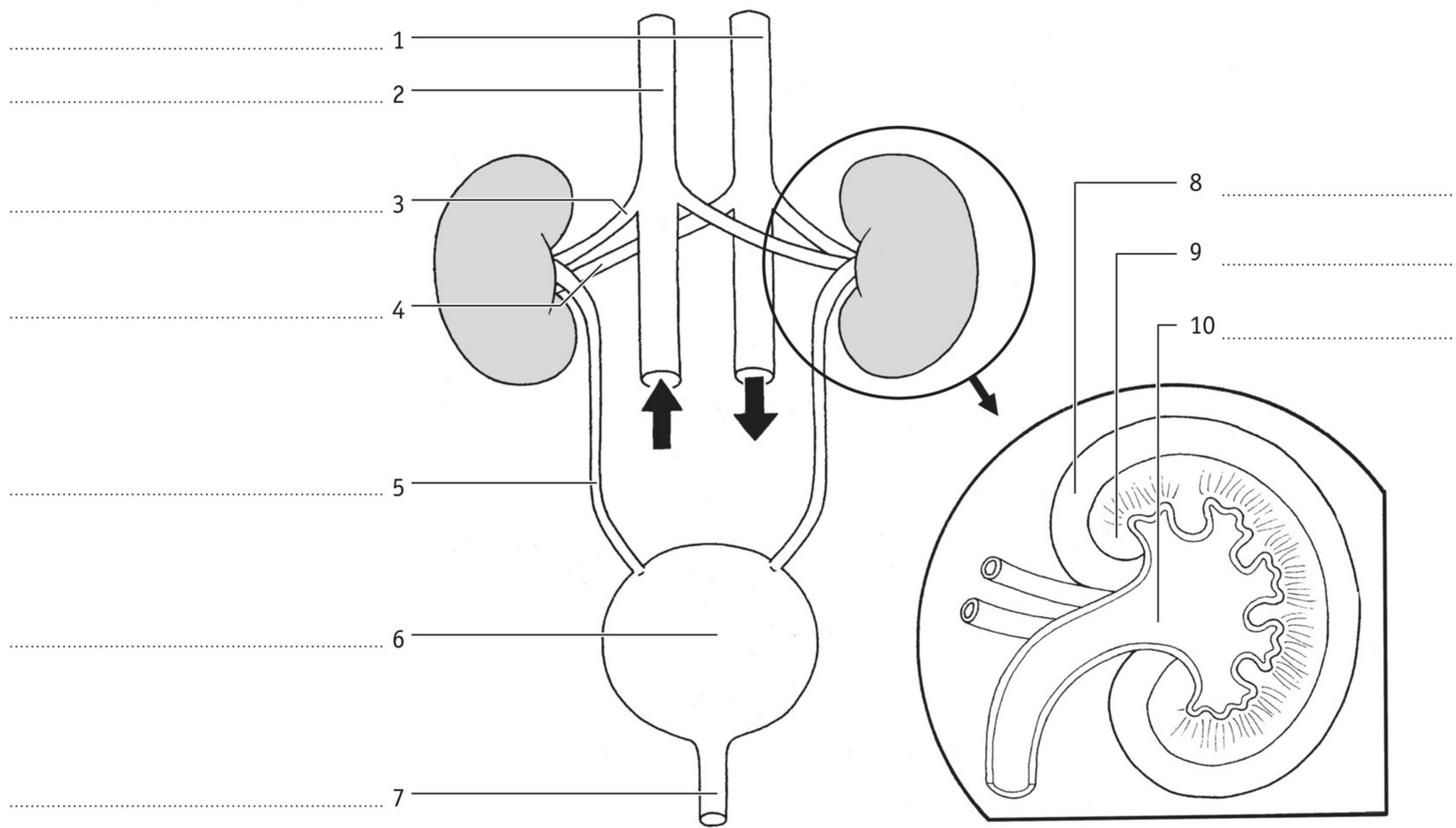
The kidneys are connected to the aorta and the inferior vena cava.

- Blood enters a kidney through the *renal vein / renal artery* and leaves the kidney through the *renal vein / renal artery*.
- The renal artery contains *a lot of / only a little* oxygen and *a lot of / only a little* waste.
 - The renal vein contains *a lot of / only a little* oxygen and *a lot of / only a little* waste.
- Do the renal arteries separate from the aorta above or below the diaphragm? Explain your answer.

3

Write down the names next to the numbered parts in figure 4.

fig. 4 Kidneys and urinary tract.



4



Summary

Complete the text and fill in the table.

From the outside inwards, kidneys are made up of

Function:

.....

Functions	Parts
Bringing in waste substances	
Carrying purified blood away	
Making urine	
Collecting urine	
Draining urine to the bladder	
Storing urine temporarily	
Transporting urine outside the body	

INSIGHT

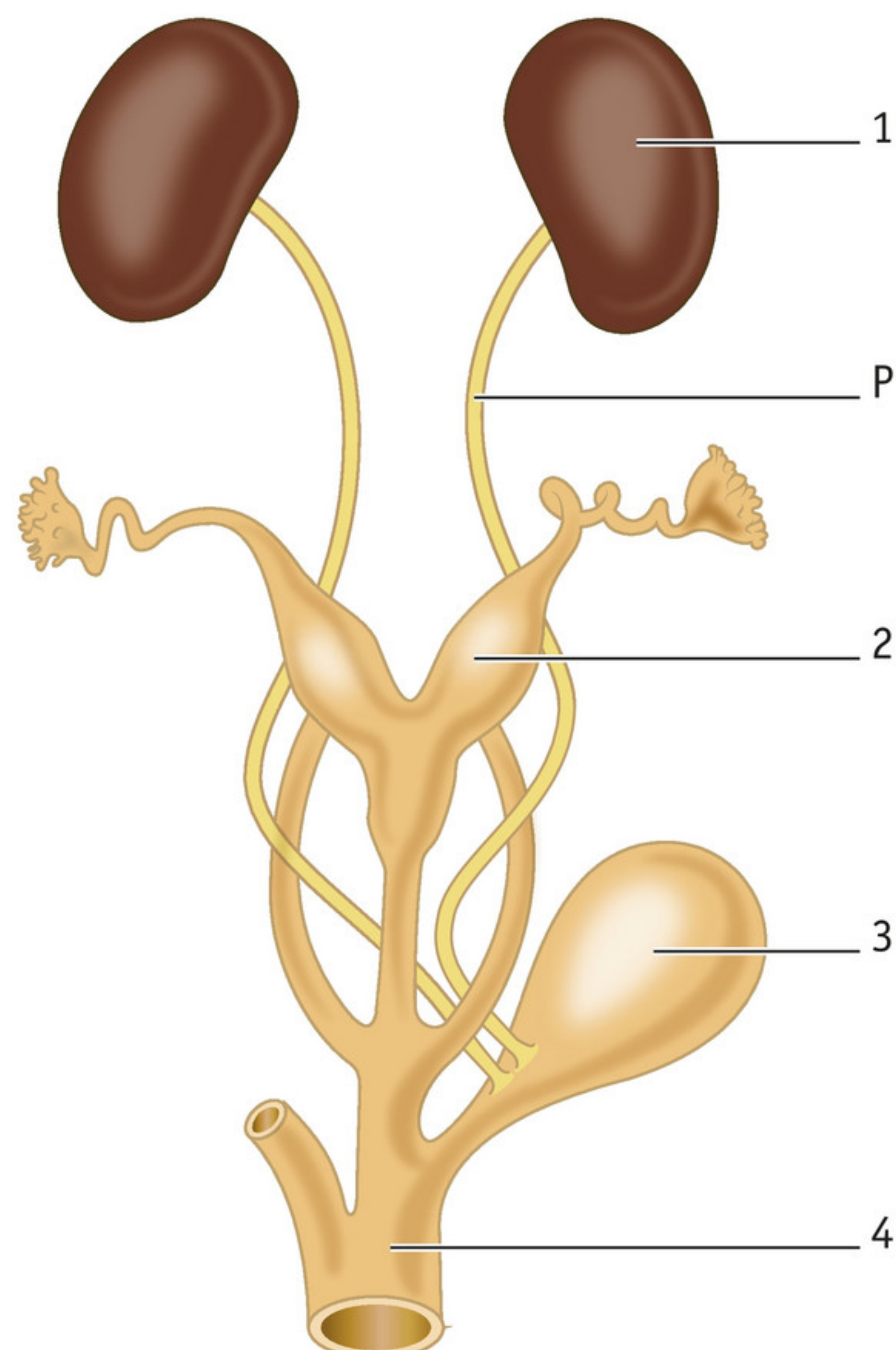
5

Kangaroos live in Australia. The high temperatures there and the lack of water are a threat to these marsupials. They keep their fluid loss low by excreting less water with their urine than many other animals. Otherwise, their kidneys work the same as human kidneys.

- a During a wet period with a lot of rain, a kangaroo drinks more than during the rest of the year. Do the kidneys produce more or less urine during those wet periods? Explain your answer.

- b** Figure 5 shows a schematic drawing of a kangaroo's kidneys, urinary tract and other organs. Their urinary tract differs from the human one, but the function is similar. Which of the numbered parts is the bladder? part 1 / 2 / 3 / 4
- c** What fluid does organ P contain? *blood / urine*

fig. 5 Kidneys and various other organs of a kangaroo.



6

A low fluid intake can lead to kidney stones (see figure 6). They often occur in the renal pelvis and can vary in size from a grain of sand to a walnut.

- a** Smaller stones are flushed out with the urine when they come loose. That is painful and sometimes causes blood in the urine.
What causes the blood in the urine?
- b** Why do large kidney stones often not lead to pain and blood in the urine?

fig. 6 Kidney stones.



7

Bladder infections occur much more often in girls and women than in boys and men. This is due to their differing anatomy. In girls, the anus and the urethra are close together, while in boys the distance between the anus and the urethra is greater.

- a** Explain why the distance between anus and urethra affects the occurrence of bladder infection.
- b** Have a look at figure 3.
Can you see another difference in build between girls and boys that makes it easier for girls to get a bladder infection?

+ 8

Birds do not urinate like mammals: they pee and poo at the same time. They get rid of everything in one go via the same exit, the cloaca. As well as undigested food from the intestine, bird droppings contain urine, which can be identified by the white colour (see figure 7). That is because of uric acid, a compound that is in the liquid in higher concentrations than urine, which is more watery.

- a Do birds have kidneys? Explain your answer.
- b Mammals have a bladder where they collect (watery) urine until the bladder is full. Birds do not have a bladder. Explain how that fits in with the way birds live.

fig. 7 Bird droppings on a car.



HOW IT FITS TOGETHER the living world

KIDNEY PATIENT: ALWAYS TIRED, ALWAYS THIRSTY

Life is very different if your kidneys do not function properly. Kidney patients know this all too well. They have to go to the hospital every other day. They are hooked up for hours on end there to a dialysis machine, which acts as a large artificial kidney. Blood from the patient's bloodstream is redirected into the device (see figure 8). It filters and purifies the blood, which is then returned to the bloodstream.

"During the treatment, there are significant changes to the mineral balance and the fluid balance," says Margreet Bosker, team leader at the dialysis ward. "The blood pump is not synchronized with the heart pump – so these people are running a kind of marathon. Afterwards, they are tired and dizzy; sometimes they have to sit here for another half hour because their blood pressure is too low."

Healthy kidneys can easily remove a lot of fluids and waste from the blood, but an artificial kidney cannot do that. Because an artificial kidney can only purify some of the blood, kidney patients follow a strict diet. They cannot eat and drink whatever they like. Because they have to go to the hospital so often, kidney patients cannot simply go on weekend trips, let alone holidays. A donor kidney can greatly improve the life of a kidney patient.

After: Trouw, 'Nierpatiënt: altijd moe, altijd dorst', Eveline Brandt, 13 September 2003.

fig. 8 Renal dialysis.



9

Read the text 'Kidney patient: always tired, always thirsty'.

- a The blood that is to be purified is taken from a vessel in an arm or leg. Why is dialysis done via blood vessels in the arm or leg and not via the renal artery?
- b A kidney patient can die if they do not get dialysis on time. Explain why the body cannot go without dialysis.
- c In one particular kidney disease, urine flows back from the bladder to the kidneys. Explain why these people are more prone to pyelitis (inflammation of the renal pelvis).
- d Why is a kidney patient always thirsty?

5 The immune system

LEARNING OBJECTIVES

- 3.5.8 You can describe how antibodies protect against infection.
- 3.5.9 You can describe how immunity is created.
- 3.5.10 You can describe what happens in the event of an allergic reaction.

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES		
	3.5.8	3.5.9	3.5.10
Remembering	1a, 2c	3cd	4
Understanding	1bc, 2abd, 3b, 5, 8a	3abe, 5, 8a	5
Using	6, 8bc, 11c	7, 8bc, 11ab	
Analysing	10	10	9

Pathogens such as bacteria and viruses cannot get into your body easily. When they do, white blood cells destroy the pathogens.

FOREIGN BODIES

Substances that do not belong in your body are called **exogenous** or **foreign substances**. Exogenous substances can make you sick. That is why your body has various barriers to keep pathogens out. The first barrier is the skin. It keeps harmful substances and organisms (such as bacteria) out. If you have a wound, bacteria can get inside the skin. When that happens, the wound gets infected.

Harmful substances or pathogens may be present in the air and in food. When you breathe or eat, substances from the environment get inside your body. In every breath, the mucous membranes in your nose stop small dust particles and pathogens. They stick to the nasal lining. Cilia move the mucus plus dust particles towards the back of the pharynx, where it is then swallowed. In your stomach, bacteria that have been transported by the mucus or in your food are killed by hydrochloric acid.

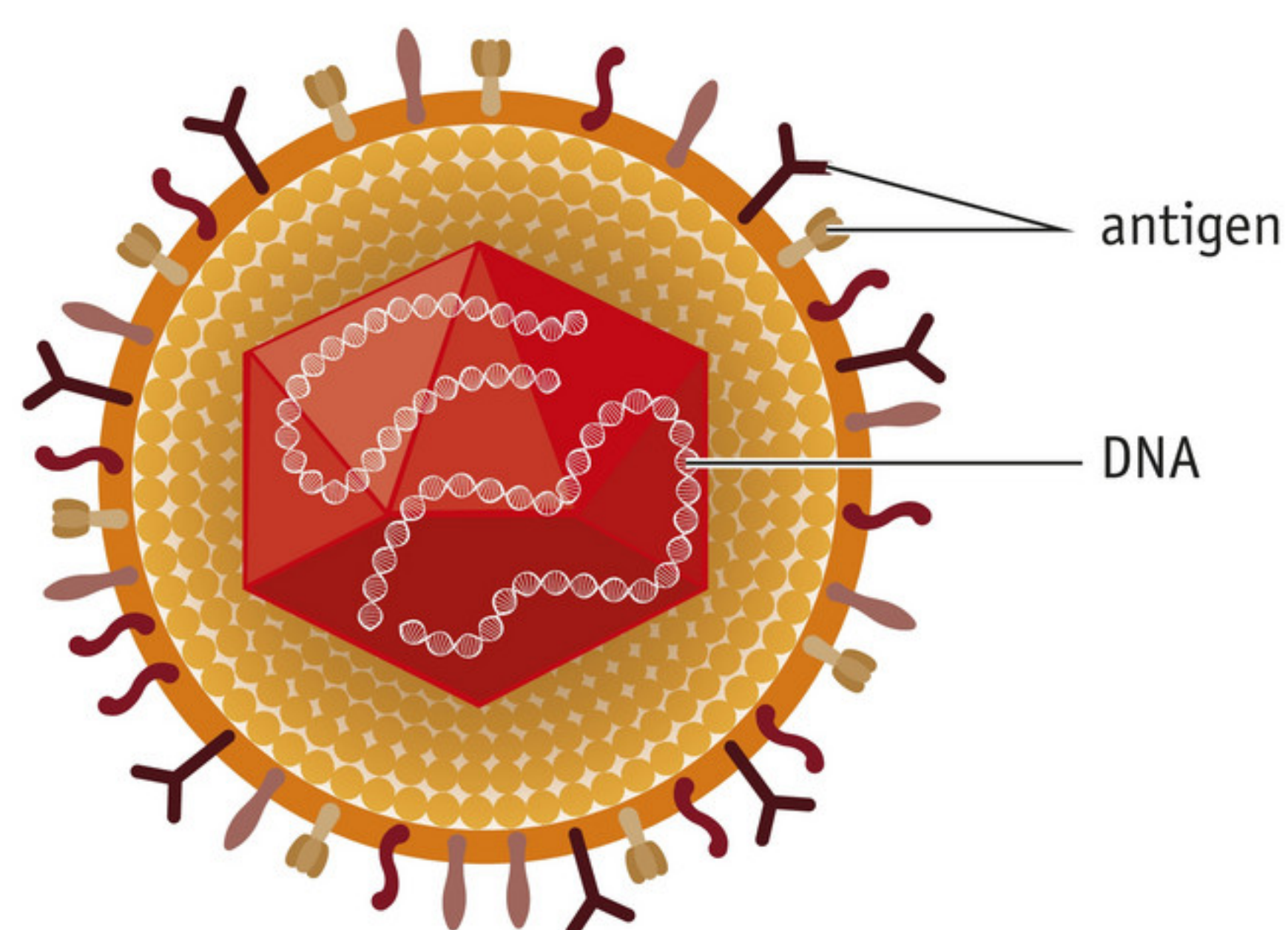
ANTIGENS

If the pathogens still manage to get inside your body, it will cause an **infection**. The **defence system** or **immune system** will then be activated and will start to fight the pathogen. The white blood cells can be seen as the immune system’s ‘soldiers’: they are sent out to find and kill the pathogens.

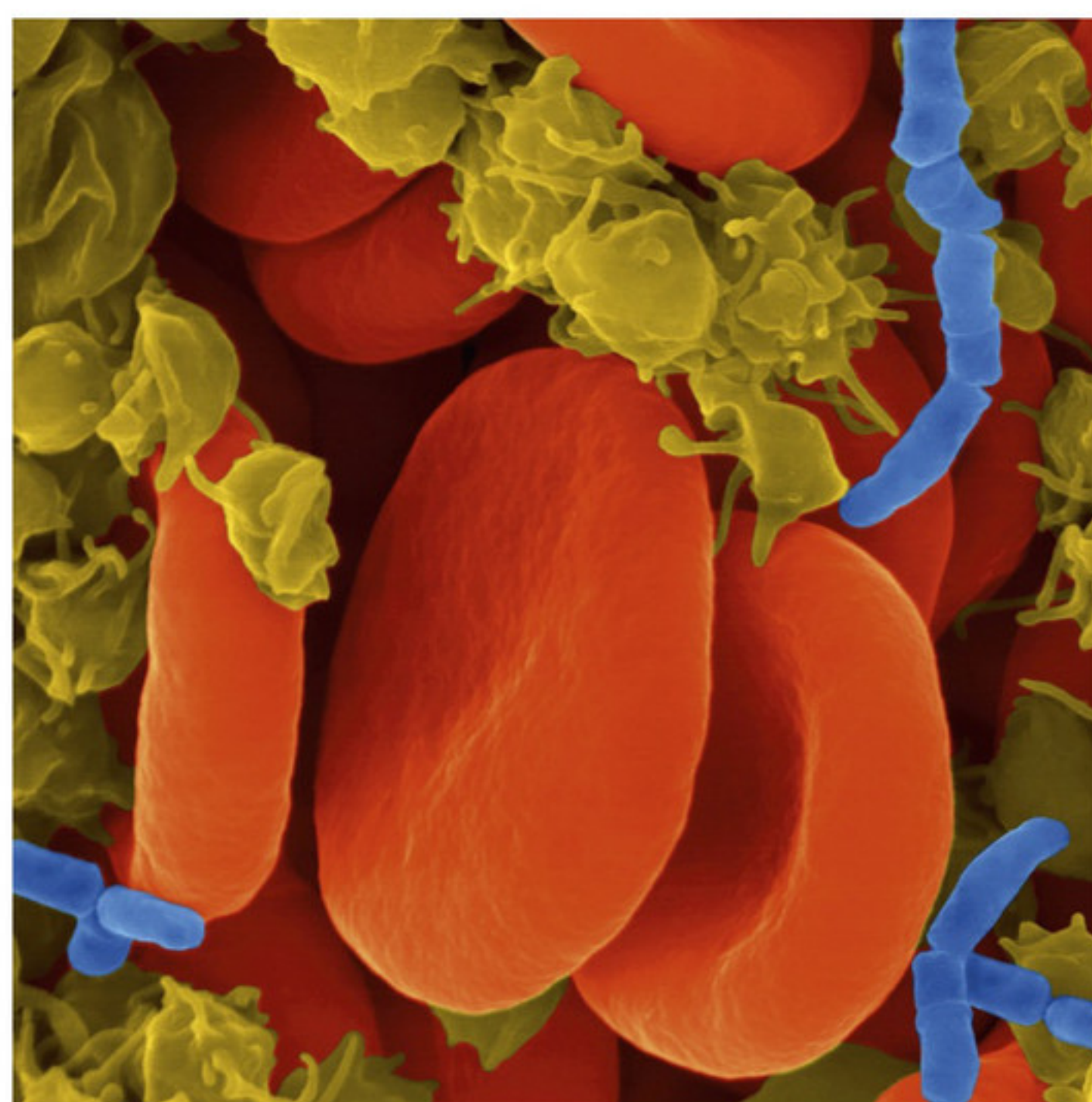
Pathogens are usually viruses or bacteria (see figures 1 and 2). Viruses are not living creatures because they do not have all the life processes. A virus consists of DNA in a shell of proteins. The immune system recognizes viruses and other pathogens by their **antigens**. An antigen is a protein on the outside of a cell or a virus (see figure 1.2). Foreign antigens activate the immune system.

fig. 1 A virus.

1 influenza virus, electron microscope image (coloured)



2 influenza virus, schematic drawing

fig. 2 Blood infection with bacteria (coloured blue).**ANTIBODIES**

Certain white blood cells destroy pathogens by encapsulating them (see figure 3). Another type of white blood cell reacts to pathogens by making **antibodies**. Antibodies are proteins that disable a pathogen. If a pathogen gets into your body, the immune system recognizes it as a foreign substance. White blood cells then produce antibodies (see figure 4). The antibodies attach themselves to the antigens of the pathogen. This disables the pathogen.

Different pathogens have different antigens. Any given type of antibody can only attach itself to one type of antigen, so your body needs to be able to make many different antibodies. Your blood transports the antibodies through your body.

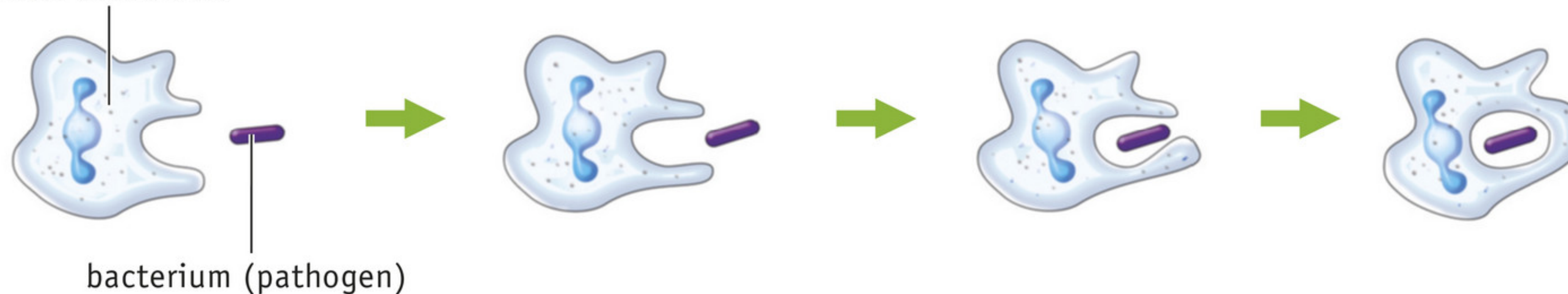
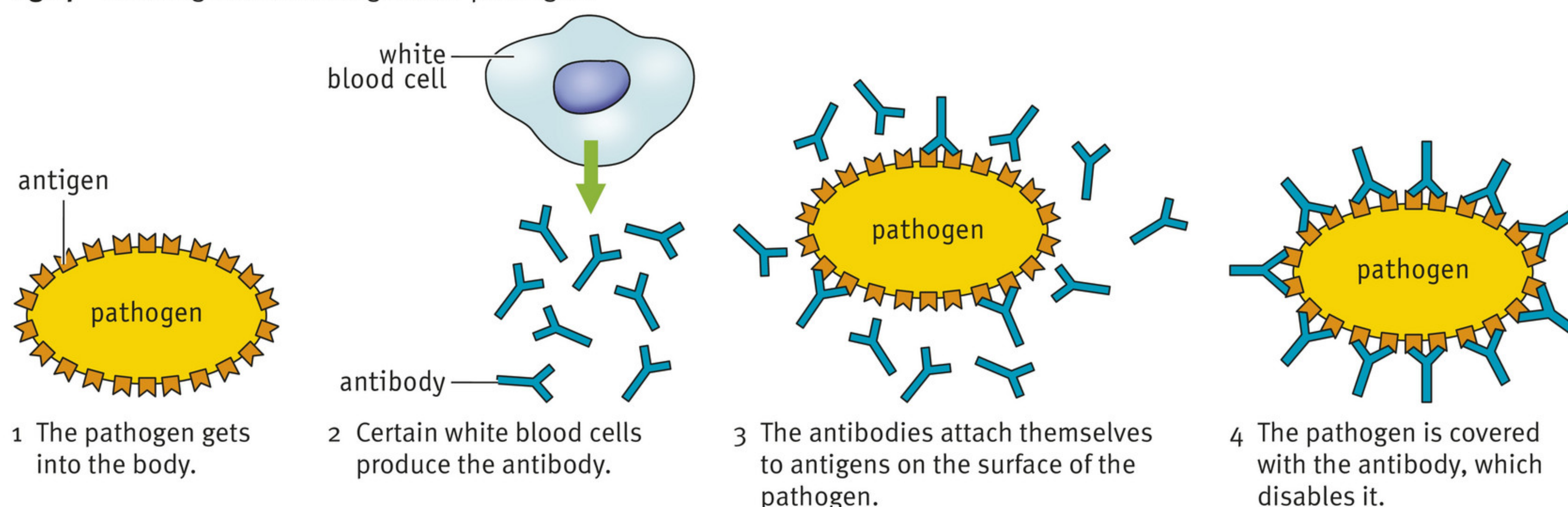
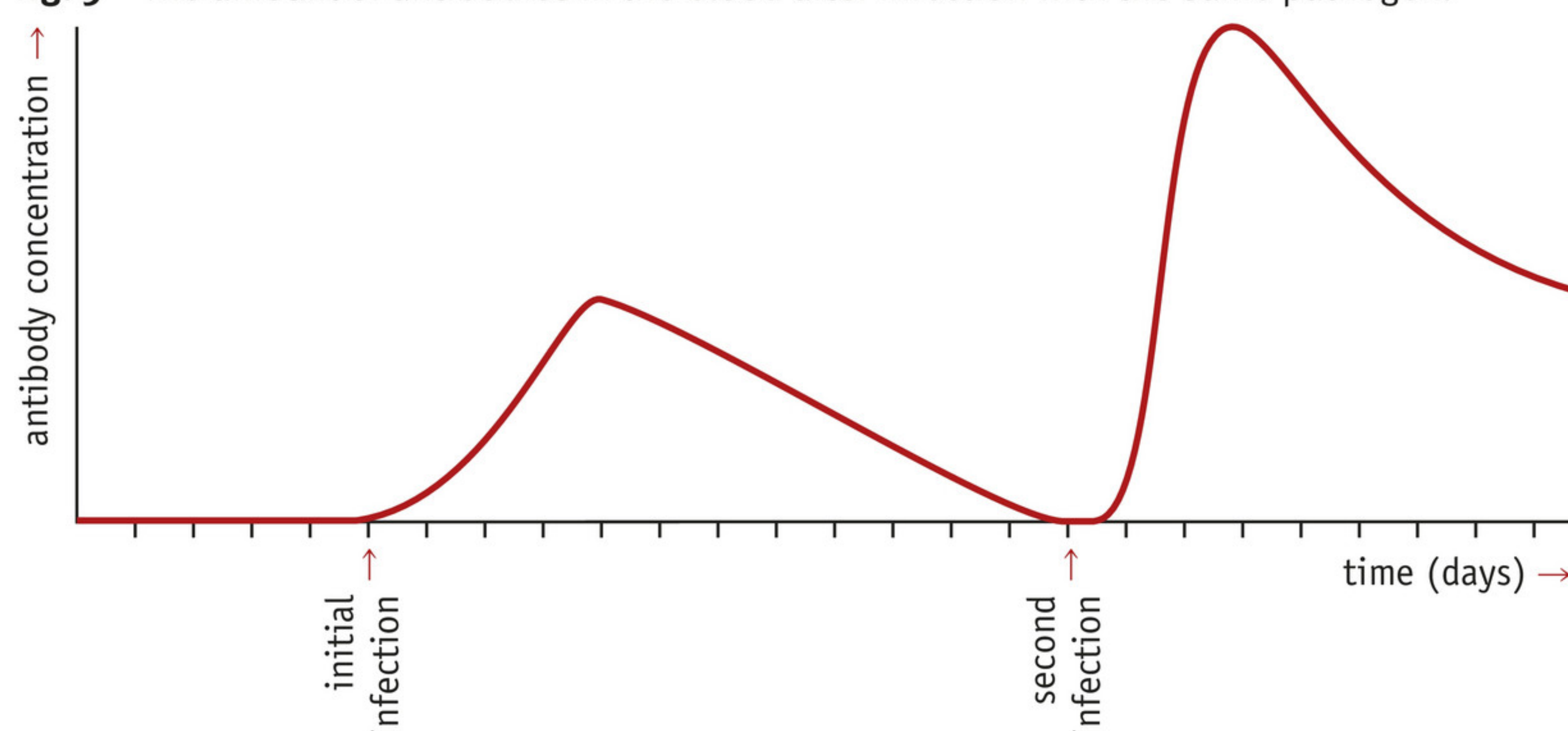
fig. 3 A white blood cell eliminating a bacterium.
white blood cell

fig. 4 Creating antibodies against a pathogen.

IMMUNITY

If you get an infection, it takes a while for the white blood cells to produce enough antibodies to deal with the pathogen (see figure 5). That is why you often get sick first. You will get better once enough antibodies have been made.

fig. 5 The amount of antibodies in the blood after infection with the same pathogen.

If your white blood cells have produced a certain type of antibody, this often remains in the blood for a while. On top of that, the white blood cells 'remember' how to produce these antibodies. If you get infected with the same pathogen again later, the white blood cells can produce these antibodies almost immediately (see figure 5). You don't get sick then: you have become **immune** to this disease.

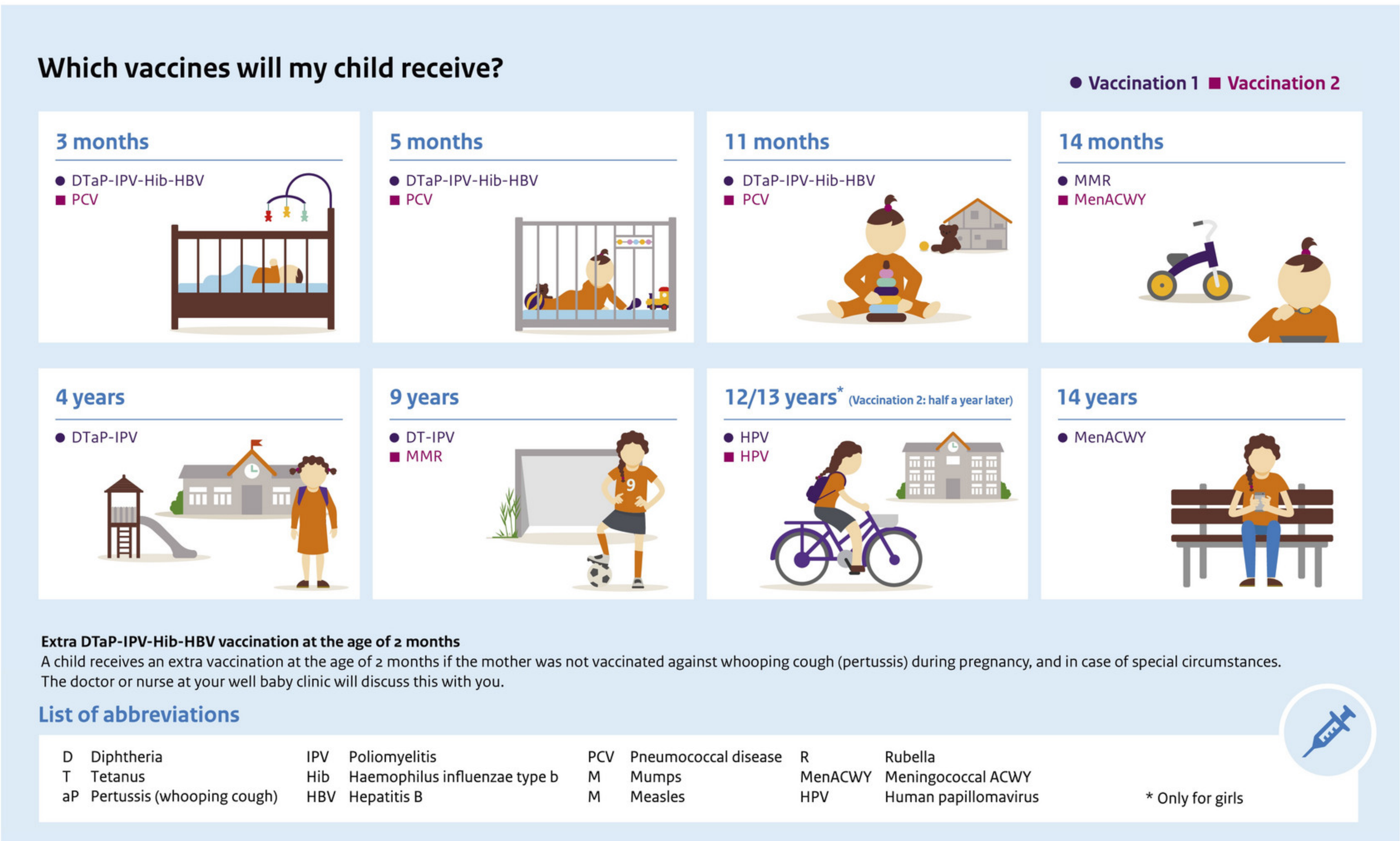
Many children get chickenpox as toddlers. They get sick and make antibodies to fight the pathogen. If they then get infected with chickenpox again, they do not get sick: they are permanently immune to chickenpox. The immunity was created because the children have been ill. This is called **natural immunity**.

It is also possible to become immune to a disease artificially. This happens when you are vaccinated against diseases like measles. When you get this type of injection or **vaccination**, you are given a **vaccine** (pronounced: vac-seen). A vaccine contains a dead or weakened (attenuated) pathogen. This doesn't make you sick, but your white blood cells will start to make antibodies. This makes you immune to this particular pathogen. Immunity through vaccination is called **artificial immunity**.

VACCINATION

In the Netherlands, children are vaccinated against several infectious diseases (see figure 6). This is called the National Immunisation Programme (Rijksvaccinatieprogramma). As a result, diseases that killed or permanently harmed children in the past, such as poliomyelitis and measles, have been virtually eliminated in the Netherlands. To protect the population as a whole, some diseases require a high **vaccination coverage**. For example, measles requires a vaccination coverage of 95% to make sure that the disease cannot spread among the population. This means that 95% of all children must be vaccinated. Some parents do not want their children to be vaccinated for everything. The reason may be that their faith does not allow it, or simply that they do not know enough about vaccination. For example, they may think that a vaccine is unnecessary or unsafe. If the vaccination coverage drops too far, young and unvaccinated children can become fatally ill.

fig. 6 National Immunisation Programme vaccination schedule.



ALLERGIC REACTION

Less than one in a million children have an **allergic reaction** to the measles vaccination. An **allergy** is when you are hypersensitive to particular substances. If you inhale these substances or they get inside your body in another way, for example with your food, you will get an allergic reaction. Your immune system reacts to the substance you are hypersensitive to. You may for instance develop redness, skin rash, a burning sensation, itching or inflammation.

Allergic reactions can sometimes get more severe as the body comes into contact with the substance you are allergic to more frequently. It can lead to swollen mucous membranes, thick lips, red blotches and shortness of breath. This is called an **anaphylactic response**. In very severe cases, blood vessels can dilate and the blood pressure can drop. This is an acutely dangerous situation that can be fatal if not treated. Young people with serious allergies should therefore always carry an EpiPen. This is a syringe filled with adrenaline, which counteracts the anaphylactic response.

People can be allergic to many different substances, such as household dust, animal hair, substances in food, chemicals, peanuts, wasp stings and substances in make-up. Keeping a diary can let you find out what exactly you are allergic to.

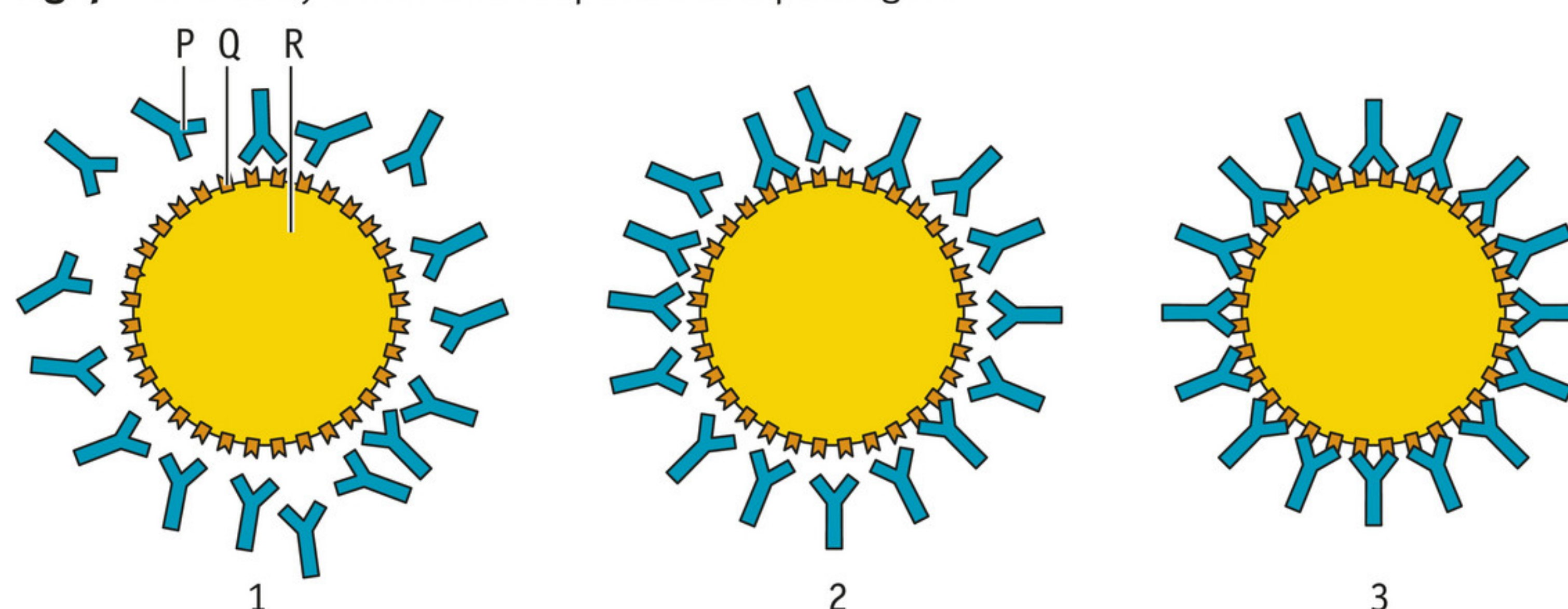
KNOWLEDGE

1

Figure 7 shows the body's immune response to a pathogen.

- a The *red / white* blood cells recognize pathogens by their *antigens / antibodies*.
- b
 - The pathogen is labelled with the letter *P / Q / R*.
 - The antigen is labelled with the letter *P / Q / R*.
- c In which drawing is the pathogen the most harmful? Explain your answer.

fig. 7 The body's immune response to a pathogen.



2

- a John has a splinter of wood in his finger. There are bacteria on the splinter.
 - The wood splinter *is not / is* a foreign body.
 - The bacteria *are not / are* foreign bodies.
- b John does not take the splinter out of his finger and gets an infection after a couple of days.
What causes the infection?
the bacteria / the splinter / both
- c What are the two ways that the bacteria are destroyed by the immune system's blood cells?
- d The splinter has passed through the skin barrier.
What other barriers to pathogens does the body have? Write down two.

3

- a When you get infected for the first time, you usually get sick, even though your body is making antibodies.
Explain why you still get sick.
- b How does a virus infection create immunity against that virus? Describe this in three steps.
- c What is the difference between natural immunity and artificial immunity?
- d What does a 'vaccination coverage of 95%' mean?
 - ☐ A 95% of people are vaccinated against an infectious disease.
 - ☐ B 95% of people do not get the infectious disease after infection.
 - ☐ C 95% of people do get the infectious disease after infection.
 - ☐ D Every person is 95% protected against an infectious disease.
- e Figure 3 shows how a white blood cell can destroy a pathogen.
Does this make you immune to this pathogen? Explain your answer.

4

- a** Some people suffer from diarrhoea, itching and nausea when they eat products containing soybeans. Their immune system reacts to the proteins in the soybean. What do we call this kind of reaction?
- b** What makes the blood pressure drop in a severe allergic reaction?

5



Summary

- Create a word web about infection, antibodies and immunity. Use the terms: *antigens – antibodies – dead or weakened pathogen – immunity – immunization (vaccination) – artificial immunity – natural immunity – harmless – white blood cells – symptoms – pathogens.*
- Complete the text about allergies.

Allergies

An allergy is

Allergic reaction:

.....

Anaphylactic response:

.....

.....

INSIGHT

6

Some bacteria can cause diseases in humans.

- a** A bacterium divides several times.
Do the new bacteria have the same antigens or different ones? Explain your answer.
- b** The bacterium *Vibrio cholerae* causes a disease called cholera. The bacterium *Mycobacterium tuberculosis* causes tuberculosis.
Do these bacteria have the same antigens or different ones? Explain your answer.

7

The childhood disease chickenpox is caused by a virus.

- a** After infection, the virus remains in the body and can cause shingles at a later age. Older people have less chance of getting shingles if they are vaccinated with a weakened chickenpox virus.
Explain why vaccination with the chickenpox virus can make elderly people immune to shingles.
- b** Wesley has had chickenpox, so his blood contains antibodies.
Are these antibodies also effective against the virus that causes measles? Explain your answer.

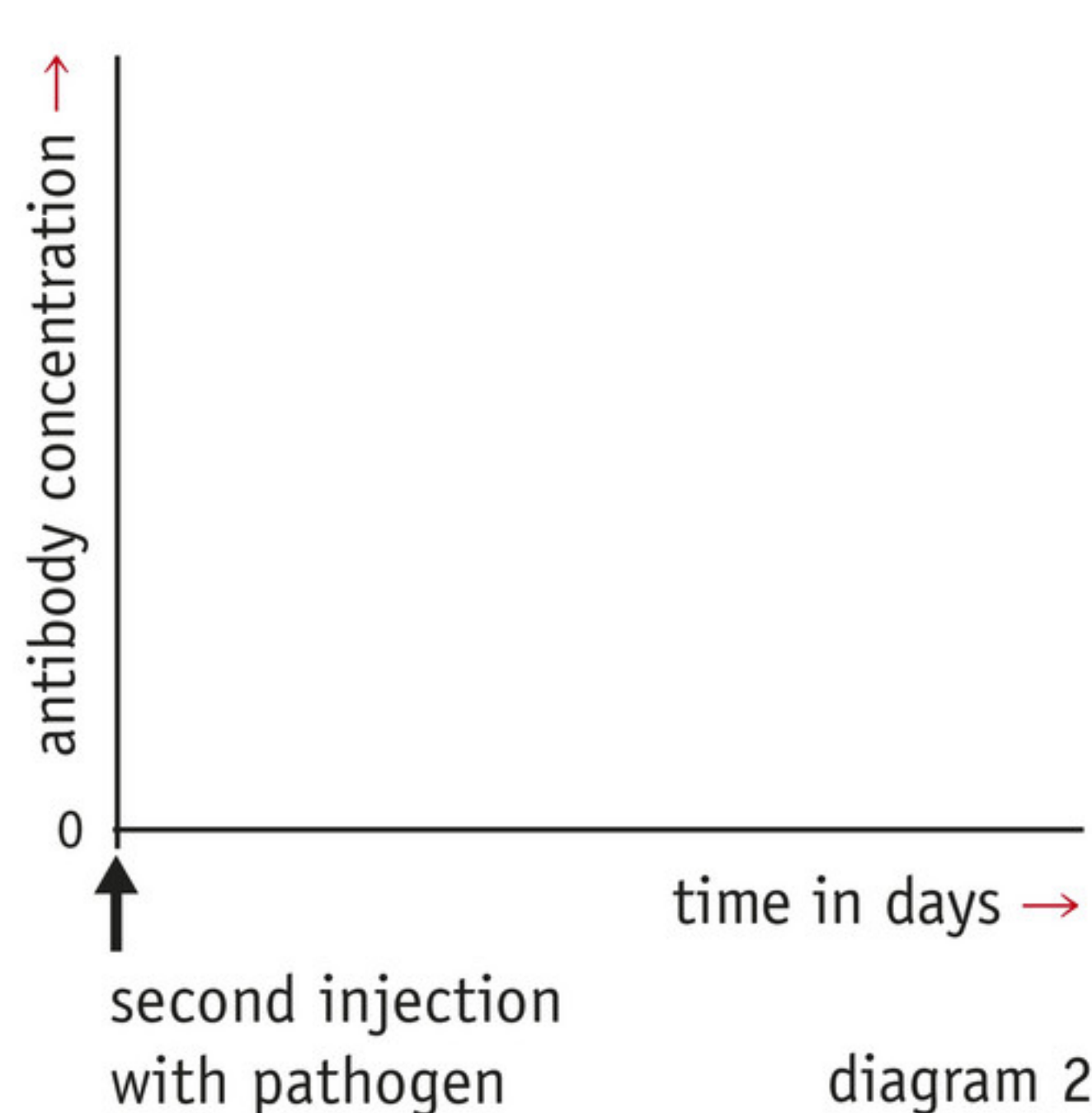
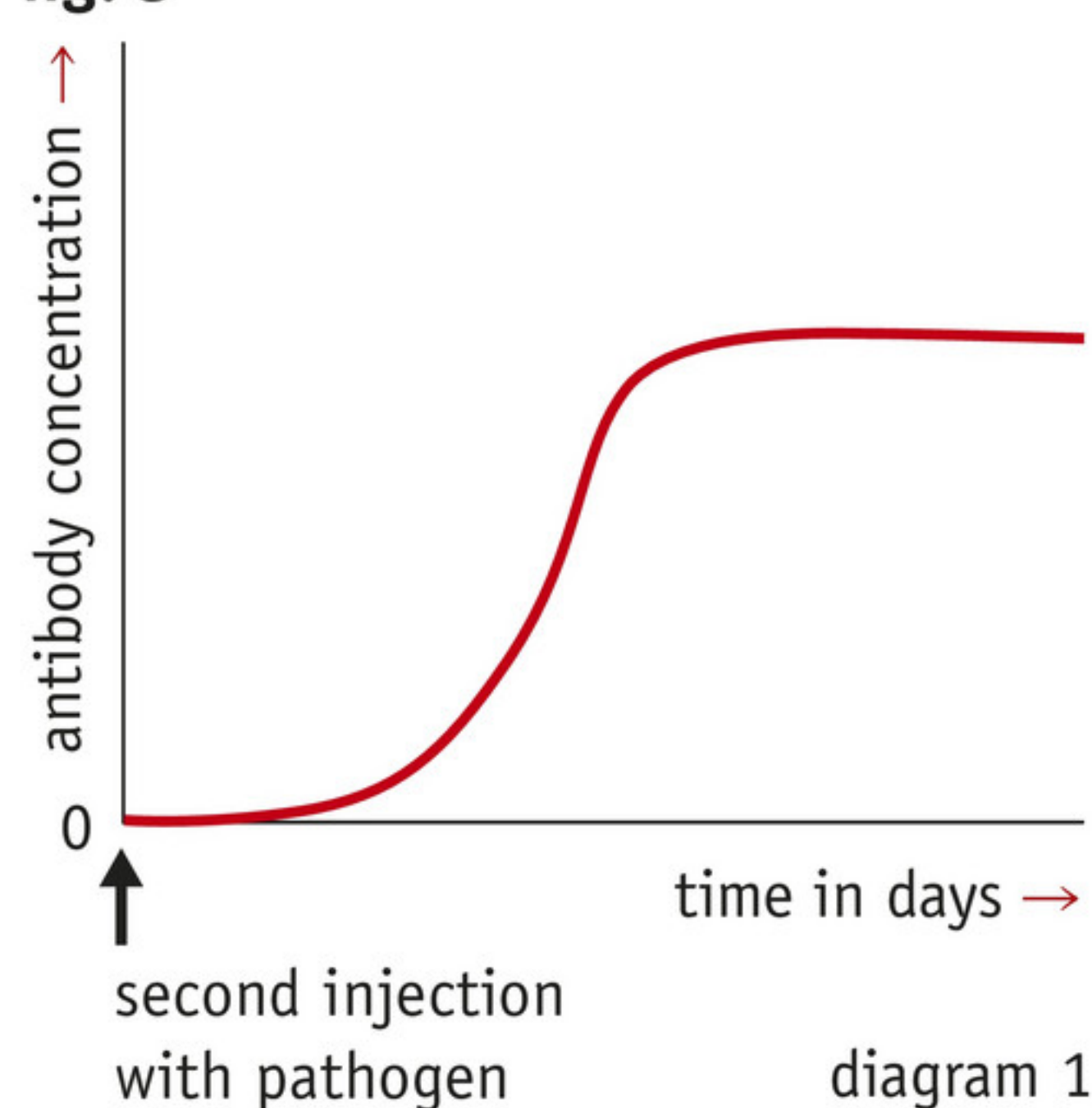
8

Flu (influenza) is caused by influenza viruses. To prevent flu, you can get inoculated with an influenza jab or a nasal spray. Flu jabs and nasal sprays contain parts of influenza viruses.

- a** Is the immunity provided by the flu shot or the nasal spray artificial or natural?
Explain your answer.
- b** What would be the risk if the flu jab or nasal spray contained complete influenza viruses rather than parts of viruses?
- c** A test subject is injected with a virus and therefore makes antibodies against this virus. Diagram 1 of figure 8 shows how long it takes to produce these antibodies. A year later, the subject is injected with the same amount of the same virus again. How much time is now needed for producing antibodies? Draw the graph in diagram 2.



fig. 8



9

- a** In an anaphylactic response, the mucous membranes in the respiratory tract start to swell.
Explain why this is dangerous.
- b** An anaphylactic response can lead to a sudden drop in blood pressure.
Explain why this is very dangerous.

+ 10

Flu is caused by an influenza virus. The antigens on the outside of flu viruses are always mutating because of environmental factors.

Explain why a person cannot become immune to flu by vaccination.

HOW IT FITS TOGETHER the living world

MEASLES IN THE NETHERLANDS

Last month, Esmee got the fright of her life. Her daughter Nynke's day care centre called to tell her that one of the children had measles. Nynke was eleven months old at that time, making it dangerous for her. Fortunately, none of the other children became infected.

But things could have been different. In 2013, for example, there was a large measles epidemic in the Netherlands and 2700 people got the disease. On the island of Tholen in the province of Zeeland, a girl died from the disease. Measles gives you a high fever, red spots and a weakened immune system. This means that the cells that recognize pathogens with which the body has been in contact in the past disappear. Infected people are therefore more susceptible to infections with other pathogens.

fig. 9 A child with measles.



11

Read the text 'Measles in the Netherlands'.

- a** What makes a measles outbreak so dangerous for children aged under 14 months in particular?
- b** What makes people infected with measles more susceptible to other diseases?
- c** Antibiotics help fight bacterial infections.
Can you fight measles with antibiotics? Explain your answer.

 Go to the *Flash cards* and the *Test yourself* section.

6 Healthy lifestyles

LEARNING OBJECTIVES

- 3.6.11

You can describe how to keep your heart and blood vessels healthy.
- 3.6.12

You can name the effects of alcohol in the short term and in the long term.
- Learning how to do research 3

► Practical activity 2

TAXONOMY	LEARNING OBJECTIVES AND EXERCISES		
	3.6.11	3.6.12	2.1.2**
Remembering	2, 3b	5b	
Understanding	1, 3ac, 4, 6	5acd, 6	
Using	7bc, 8b, 11abc	9ac	
Analysing	7ad, 8a, 10, 11de	9b	11e

** You can find this learning objective in another unit.

The blood transports all kinds of substances through the body, such as nutrients and oxygen. Harmful or addictive substances are also transported via the blood. This can damage the blood vessels.

BLOOD PRESSURE

The **blood pressure** is the pressure that the blood exerts on the walls of the arteries when it is pumped around. Blood pressure is measured using a blood pressure meter (see figure 1). With increasing effort or when you get excited, the blood pressure rises temporarily. At rest, the blood pressure drops again.

Low blood pressure is not common and usually does little harm. High blood pressure is more common and can be harmful. Causes of high blood pressure include stress, smoking, obesity and eating salty food. Long-term high blood pressure damages the artery walls.

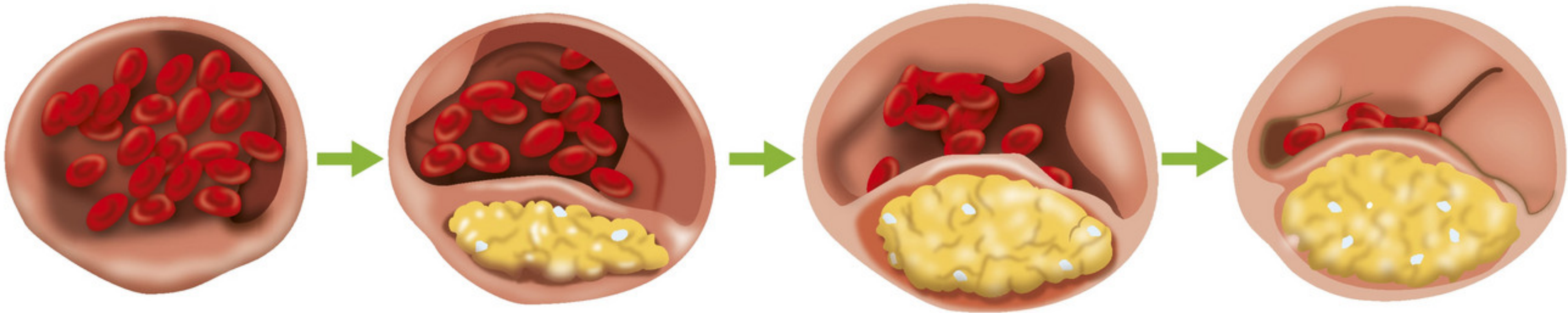
ARTERIOSCLEROSIS

When the wall of an artery is damaged, white blood cells and greasy substances from the blood can pass through it. They accumulate in the vessel wall. This creates a thickening, which eventually hardens due to calcification. This is called **arteriosclerosis** (see figure 2).

fig. 1 Measuring blood pressure.



fig. 2 Arteriosclerosis.



The vessel becomes narrower and stiffer (less elastic). This increases the blood pressure. The heart has to exert more force to pump the blood through the constricted vessels and can become overstressed. The tissue beyond the constricted blood vessel receives less blood and therefore less oxygen. As a result, the tissue or organ gets deteriorates or stops functioning altogether.

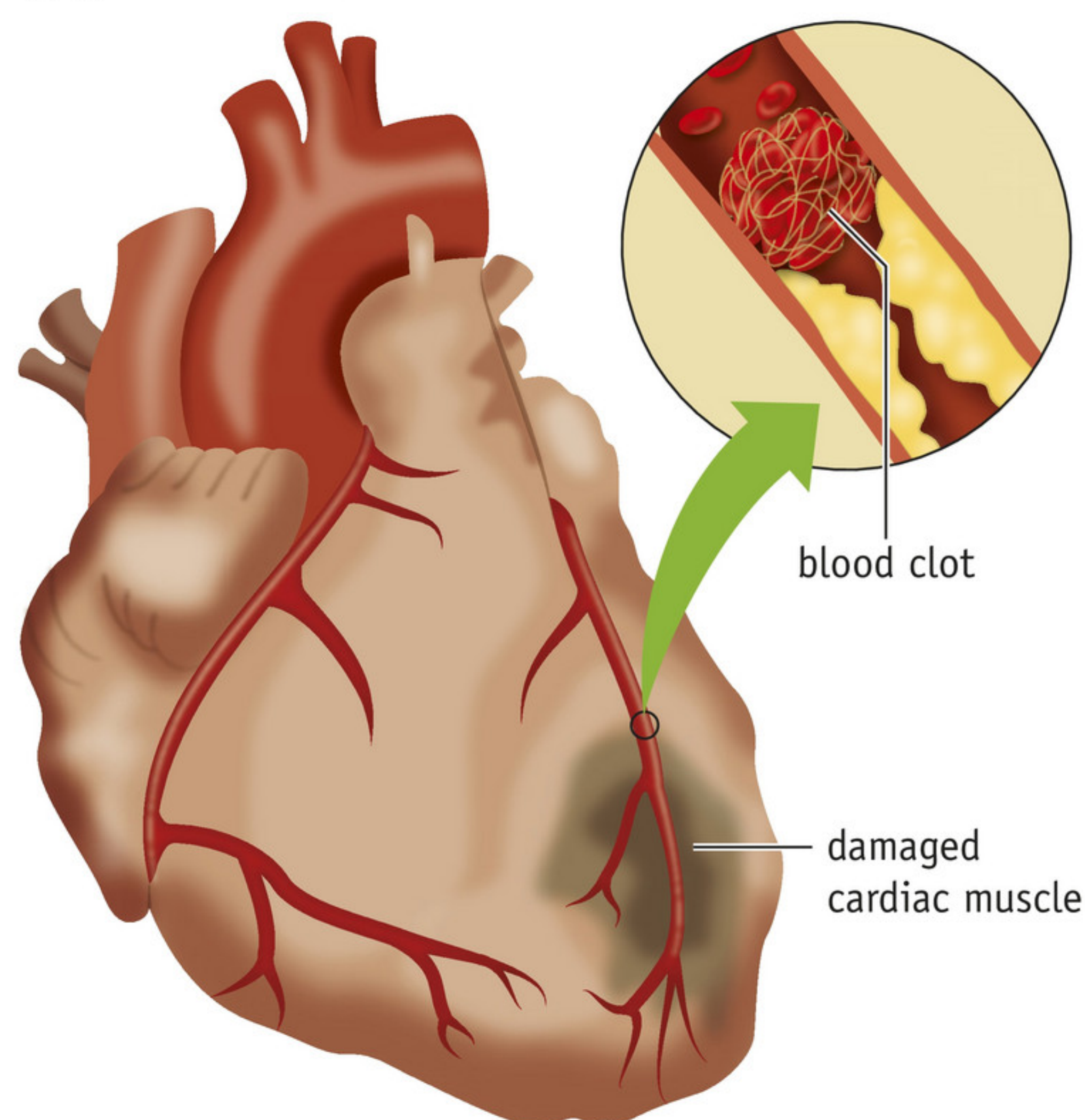
Arteriosclerosis is a process that can take years and starts at a young age. Eventually, everyone will get it, but not everyone is badly affected by it. Not smoking, eating healthily and exercising regularly all help you reduce the risk of arteriosclerosis.

HEART ATTACK

The thickening is usually not so bad that it blocks the artery completely. However, it may crack or tear the artery. If that happens, the blood clots at the cracks, creating a blood clot. This can be compared to a small wound on the skin that has a scab on it. Blood clots like these can close off the artery quickly, though. It is also possible for some of the blood clot to break off. It is then carried through the bloodstream. Further along the bloodstream, the clot can enter a vessel that it does not fit through. That vessel then suddenly gets clogged.

If this happens in a coronary artery, someone has a **heart attack** (or **myocardial infarction**). Part of the heart is suddenly deprived of oxygen and gets damaged (see figure 3).

fig. 3 A heart attack.



HEALTHY LIFESTYLE

Healthy living reduces the risk of cardiovascular disease. **Cardiovascular disease** is the collective name for diseases of the heart and blood vessels. Some people are more likely to get cardiovascular diseases due to hereditary factors. There is nothing you can do about these causes. In most cases, you can influence other causes of cardiovascular disease. The most important thing is a healthy lifestyle (see figure 4).

fig. 4

A healthy lifestyle

- 1 Not smoking is very important for the heart and blood vessels.
- 2 Do not drink alcohol, and after you are 18, do not drink more than one glass a day.
- 3 Eat a healthy and varied diet (lots of vitamins, minerals and fibres, little saturated fat and salt).
- 4 Exercise regularly (at least half an hour a day).
- 5 Avoid stress and make sure you relax enough.

Source: Dutch Heart Foundation.

Stress and tension increase the risk of high blood pressure and cardiovascular disease. Stress can be seen in tense jaws or a tense face, rapid or deep breathing or a feeling of tightness around the chest. Your emotions or behaviour can also show that you are suffering from stress. For example, you may get angry faster or feel frustrated. Some people are more anxious or nervous. You may also tend to avoid certain situations or become withdrawn.

If you are stressed or tense, try to do something about it (see figure 5). See your doctor if the stress continues to bother you.

fig. 5

Seven tips for less stress

- 1 Write down what you like and make time for it.
- 2 Clean your room thoroughly: it will also clear your head.
- 3 Make sure you have time for unexpected events.
- 4 Do one thing at a time and take your time.
- 5 Choose a healthy lifestyle (see figure 4).
- 6 Keep a regular day-night rhythm.
- 7 Try not to fit in too many activities in a day.

Source: Dutch Heart Foundation.

ALCOHOL

Alcohol is a chemical with a narcotic effect. When someone drinks alcohol, it is transported in the blood to almost all parts of the body. This affects all kinds of organs, such as the liver, the senses and the nervous system. Drinking alcohol decreases the powers of perception and the ability to react. It takes away inhibitions, reduces the ability to remember things and stops you from criticizing yourself. The more someone drinks, the stronger the effects.

Young people are extra sensitive to the effects of alcohol. They therefore run a greater risk of brain damage after drinking alcohol. This is because the brain continues to develop up to roughly the age of 24. Alcohol disrupts that development. The risk of addiction is also greater in young people. In the Netherlands, selling alcohol to people under 18 is therefore prohibited.

Alcohol is absorbed into the blood through the stomach and intestines and is broken down in the liver. The breakdown products are excreted through the kidneys in the urine, along with a lot of fluids from the body. After drinking alcohol, you can get a **hangover**. A hangover often causes headaches and makes you very thirsty. You can also be nauseous. A hangover is mainly caused by loss of fluids and by the toxic substances produced by the breakdown of alcohol.

Alcohol is absorbed into the blood and then spreads through the body fluids. The alcohol level in the blood is expressed in a blood alcohol content or BAC (the symbol for it used in some countries, including the Netherlands, is ‰). One promille of alcohol (1‰ or a BAC of 0.1%) means one milligram of alcohol per millilitre of blood. The larger the body, the more liquid it contains. A glass of alcohol therefore gives a higher alcohol content in a smaller body than in a larger body.

Table 1 Short-term effects of alcohol consumption.

Promille (‰)	Number of glasses (adults)	Effects	Effects
0.5	1 (F) 1–2 (M)	stimulating	A person feels alert, relaxed, cheerful and more talkative. The appetite increases. The pulse and respiration rate are faster and the blood vessels dilate, making you feel warm.
0.5 to 1.5	2–5 (F) 3–7 (M)	reduced inhibitions	Mood and behaviour change. Natural inhibitions decrease, people think they can do more (reckless), the memory becomes poorer, reaction speed is reduced. Dangerous in traffic.
1.5 to 3	6–9 (F) 8–14 (M)	reduced control	Muscle control is reduced. A person gets overly emotional, laughs or cries more easily, gets angry more easily. There is a lack of self-criticism, the face turns red. There is a risk of a blackout (cannot remember what happened the next day).
3–4	10–13 (F) 15–19 (M)	anaesthesia	Senses are numbed. People get confused, don't know what they hear or see.

F = female, M = male

Source: Jellinek Clinic.

If someone drinks more than indicated in Table 1, they can lose consciousness. This is called **alcohol poisoning**. Young people can get alcohol poisoning from seven glasses (1.7‰). Above 4‰, a person can fall into a coma and die.

The risk of alcohol poisoning is particularly high when **binge drinking**. Binge drinking means drinking a lot of alcohol in a short period, which means that the alcohol content in the blood increases rapidly to 0.8‰ or higher. The sudden high concentration of alcohol can seriously damage organs, especially the brain.

Alcohol consumption also has long-term effects:

- Alcohol disrupts the development of the brain.
- Alcohol disrupts the hormonal balance.
- Liver, brain, stomach and heart can get damaged.
- Memory declines, as does performance at school, study and work.

KNOWLEDGE

1

High blood pressure can be harmful.

- How can you find out if your blood pressure is too high?
- A doctor measures the blood pressure in a *brachial vein* / *brachial artery*.
- After a quiet breakfast, Abe goes running for an hour. He measures his blood pressure after breakfast and immediately after running.
The blood pressure after breakfast will be *higher* / *lower* than the blood pressure immediately after running.

2

Damage to the wall of an artery can lead to arteriosclerosis.

- What is the consequence of arteriosclerosis for a blood vessel?
- Arteriosclerosis makes the blood pressure *decrease* / *increase*.
- Due to arteriosclerosis, the heart muscle must exert *more* / *less* force.

3

Figure 6 shows the average risk of a heart attack plotted against smoking in a diagram.

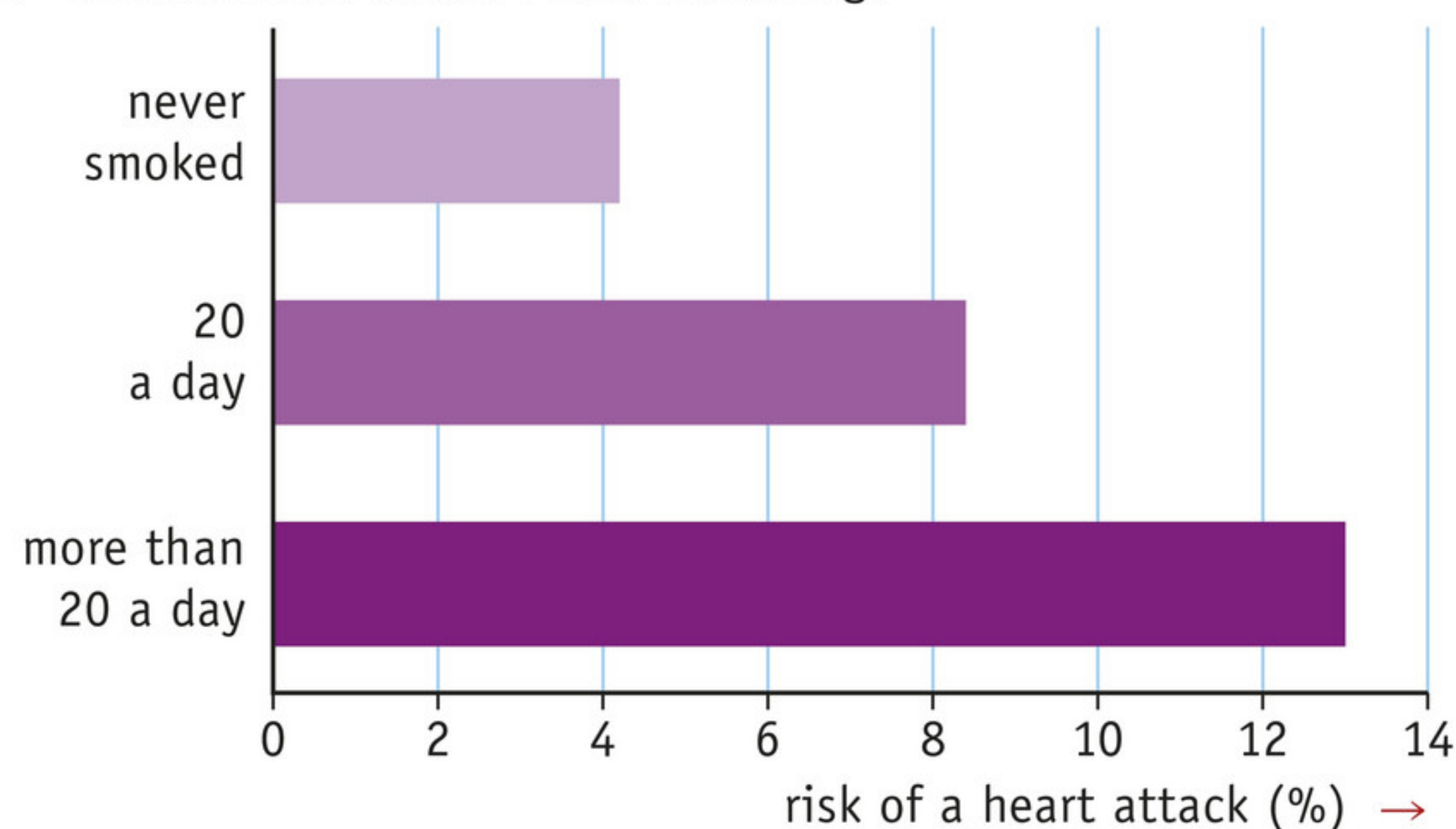
a What happens in a heart attack?

b How big is the average risk that someone who has never smoked will have a heart attack?

About% on average.

c If someone smokes a packet of cigarettes a day, how many times higher is their risk of a heart attack compared to someone who does not smoke? about 2 / 3 / 4 / 5 / 6 times higher

fig. 6 Risk of heart attack versus smoking.



4

A healthy lifestyle helps prevent cardiovascular disease.

a Which rules fit a healthy lifestyle?

- ☐ a Exercise regularly.
- ☐ B Drink alcohol regularly.
- ☐ C Eat the same food often.
- ☐ D Don't smoke much.
- ☐ E Avoid stress.

b Which tips can help to prevent stress?

- ☐ A Do things you enjoy.
- ☐ B Do lots of things at once.
- ☐ C Go to bed at a different time every day.
- ☐ D Reserve time for unexpected events.
- ☐ E Plan lots of activities in one day.
- ☐ F Clean your room.

c Explain how stress can cause cardiovascular disease.

5

Alcohol takes away inhibitions, affects memory and limits self-criticism.

a Which organ is responsible for these changes?

b Alcohol is broken down in the

c Alcohol makes you urinate *more* / *less*.

d One glass of alcohol in a larger body gives a *higher* / *lower* alcohol level than in a smaller body.

6



Summary

Fill in the tables and complete the text.

Description	Disorder	Causes	Effects
High pressure that the blood exerts on the wall of the arteries			
Narrowing of the blood vessels			
Part of the heart muscle is no longer being supplied with oxygen and nutrients			

The short-term consequences of alcohol consumption	The long-term consequences of alcohol consumption

You can reduce the risk of getting cardiovascular diseases by:

.....

.....

.....

.....

.....

.....

INSIGHT

7

Surprising fact: sweet liquorice contains more salt than the salty versions that are also popular in the Netherlands. Liquorice sweets contain more sugar, which masks the taste of the extra salt. All liquorice also contains another substance that can cause high blood pressure, glycyrrhizin. Salt and glycyrrhizin make the body retain fluids.

a What makes your blood pressure increase when you retain more fluids?

b Liquorice root also contains glycyrrhizin.

Can drinking large amounts of liquorice root tea lead to high blood pressure?

c The Netherlands Nutrition Centre recommends that children eat no more than five pieces of liquorice (25 g) a day. Liquorice sweets contain 0.2 g salt per 100 g.

How many grams of salt are there in five pieces of liquorice? g

d According to the Netherlands Nutrition Centre, you should not eat more than five grams of salt per day. Compare this maximum amount with your answer to Question (c).

Why does the Netherlands Nutrition Centre recommend eating no more than five pieces of liquorice a day?

8

a In a heart attack, a coronary artery becomes clogged, which cause part of the heart to die off.

Explain why a lack of oxygen makes cells die off.

b A Dutch cardiologist (heart specialist) warns teenagers, “If you want to avoid heart attacks later in life, you should live more healthily during puberty.” She adds, “The main cause of heart attacks is arteriosclerosis. Once you get that, it will never go away. It is a process that starts in your youth and can accelerate if you live an unhealthy lifestyle.”

What can you do to prevent heart attacks later in life?

9

a Alcohol is bad for school and work performance.

Explain how alcohol negatively affects performance at school and work.

b Alcohol is toxic. This is especially apparent when someone drinks too much. What shows you that alcohol is toxic?

c At a blood alcohol content of more than 0.5‰ (and 0.2‰ in inexperienced drivers), you cannot drive a vehicle in traffic.

Give two reasons why alcohol in your blood is dangerous when you are driving a vehicle.

+ 10

a A small amount of coagulated blood can get trapped in a vessel. Blood clots like these can make cells die off.

What makes the cells beyond a blood clot die off?

b A blood clot can be in an artery, for example in a brachial artery. To prevent cells beyond this blood clot from dying off, a doctor may prescribe anticoagulants (blood thinners). However, using blood thinners in the event of a blood clot also has risks. Explain the potential danger of blood thinners.

HOW IT FITS TOGETHER the living world

AGEING HEALTHILY

Who wouldn't want to age healthily? It does take some effort, though. Ageing has a lot to do with your lifestyle and much less with your hereditary predisposition. This is the conclusion of research carried out in parts of Italy and Japan that have more centenarians on average than elsewhere.

It appears that people who have lived to a hundred years or more live active lives. They are physically busy all day, which means they are less overweight. They also have lower blood pressure and fewer of them have diabetes or cardiovascular disease.

A second factor is the diet. The centenarians have eaten lots of fresh fruit and vegetables all their lives. They also ate more fish and less meat and salt. They also used little saturated fat, but did consume vegetable oil and they also ate with moderation. In addition, their alcohol consumption was limited. They also had good social lives with little stress. So, if you want to run up a mountain in your nineties, you should start these healthy habits now.

fig. 7



11

Read the text 'Ageing healthily'.

The text mentions several factors that help you age healthily.

- a Highlight all these factors in the text.
- b Which of these factors do you already apply in your lifestyle?
- c What can you do to improve your lifestyle to make it healthier?
- d Explain why a good social life leads to a higher life expectancy.
- e Why does food with less saturated fat increase the life expectancy?

 Go to the *Flash cards* and the *Test yourself* section.

How it fits together

A HORSESHOE CRAB ON THE APPLE JUICE

Have you ever been to the blood bank? People sit there in a row with needles in their arms to donate blood. In laboratories on the North American coast, it's horseshoe crabs rather than people who are lined up for blood donations.

BLUE BLOOD

Horseshoe crabs (*Limulus polyphemus*) are arthropods with a long tail in the shape of a dagger (a long, narrow sword). They also have typical armour in the shape of a horseshoe (see figure 1). That is why they are called 'horseshoe crabs'. Furthermore, they have blue blood instead of red. This is because their blood contains haemocyanin instead of haemoglobin. Oxygen-rich crab blood is dark blue and deoxygenated blood is very light blue. The blood of horseshoe crabs has another special feature: it can show the presence of bacteria. This is why companies are taking blood from horseshoe crabs.

fig. 1 Collecting blood from horseshoe crabs.



CLOTS

In addition to haemocyanin, the blood of horseshoe crabs contains a type of white blood cell that recognizes bacteria by antigens on their cell membranes. If a dangerous bacterium gets into the blood of a horseshoe crab, the blood cells form gel-like clots around the bacterium. This is an excellent defence against infections for horseshoe crabs, so good that many companies want to use it. Laboratories use the blood to test vaccines, needles, pacemakers and artificial hips for contamination with dangerous bacteria. The blood of the horseshoe crab is also used in space. Sick astronauts can test whether they have a dangerous infection. With horseshoe crab blood, you can detect bacteria even though it would otherwise be like looking for a grain of sand in an Olympic pool.

A lot of horseshoe crab blood is needed for testing medical devices. To that end, about half a million animals are caught every year off the American coast. Lab technicians draw between 50 and 400 mL per donation, depending on the size and gender of the horseshoe crab. After giving blood, the crabs get a glass of apple juice and some cookies. Then they are marked to show that they've donated blood and are put back in the sea. Perhaps it will soon no longer be necessary to catch these horseshoe crabs. Scientists have changed the DNA of a yeast called *Saccharomyces cerevisiae* so that it can produce the same recognition substance as in the horseshoe crab blood. This is good news – for the crabs too!

EXERCISES

1

Study figure 2.

fig. 2 The circulation of a horseshoe crab.

- a** The pericardium is a protective layer around the heart. The horseshoe crab's respiratory system is different from that of humans.

A horseshoe crab's way of breathing is most similar to that of:

- ☐ A unicellular organisms
- ☐ B insects
- ☐ C fish
- ☐ D birds

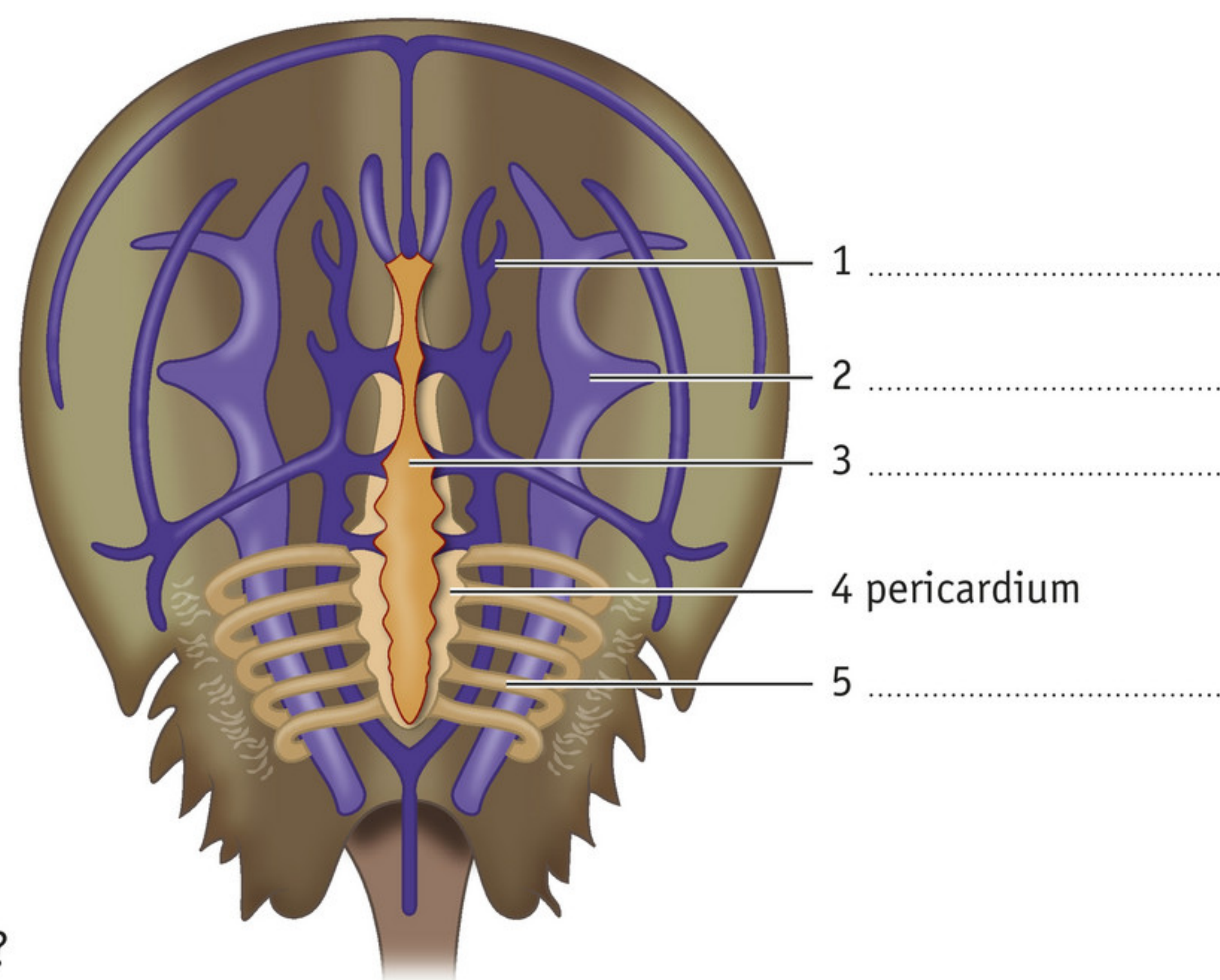
- b** The horseshoe crab has an open circulation. This means that the arteries and veins are not connected together by capillaries. Do the cells still get oxygen? Explain your answer.

- c** Write down the names next to the numbered parts in figure 2. Use the terms: *vein* – *heart* – *gills* – *artery*.



- d** What direction does the blood of the horseshoe crab flow in? Show this with arrows in the veins, arteries and gills in figure 2.

- e** Does the horseshoe crab have a double circulatory system? Explain your answer.



2

The blood of the horseshoe crab contains haemocyanin.

- a** What is the function of haemocyanin?

- ☐ a removing waste substances from the blood
- ☐ b protection against pathogens
- ☐ C oxygen uptake and release
- ☐ D blood coagulation

- b** When a laboratory technician takes blood from a horseshoe crab, they insert a hollow needle into the animal. The blood then starts to run out spontaneously. Does the technician take blood from the crab from arteries or veins? Explain your answer.

- c** After the blood donation, horseshoe crabs are given apple juice to drink.

What does apple juice replenish in the blood?

- d** People are also given juice to drink after they have donated blood.

What is it needed for?

- e** It is possible that horseshoe crabs get stressed when their blood is being taken. The heart of a horseshoe crab reacts to stress in the same way as a human heart. How could you measure stress in a horseshoe crab?

3

- a** Horseshoe crab blood forms gel-like clots around dangerous bacteria. This does not kill the bacteria but they cannot spread further through the body.

What life process can the bacteria no longer carry out because of the gel?

- b** Horseshoe crab blood can be used to detect dangerous bacteria. These bacteria are only toxic if their cell membrane breaks down.

Explain why antibiotics can be dangerous when treating such bacteria.

- c** Why are pacemakers, artificial hips, needles and vaccines tested for the dangerous bacteria (and not shampoos, for example)?

- d** Why is it not necessary to test foods with horseshoe crab blood?

- e** Toxins can pass through the wall of the small intestine.

Which organ will they arrive at first? Explain your answer.

7 Tissue fluids and lymph

LEARNING OBJECTIVE

3.7.13 You can name the characteristics and functions of tissue fluid and lymph.

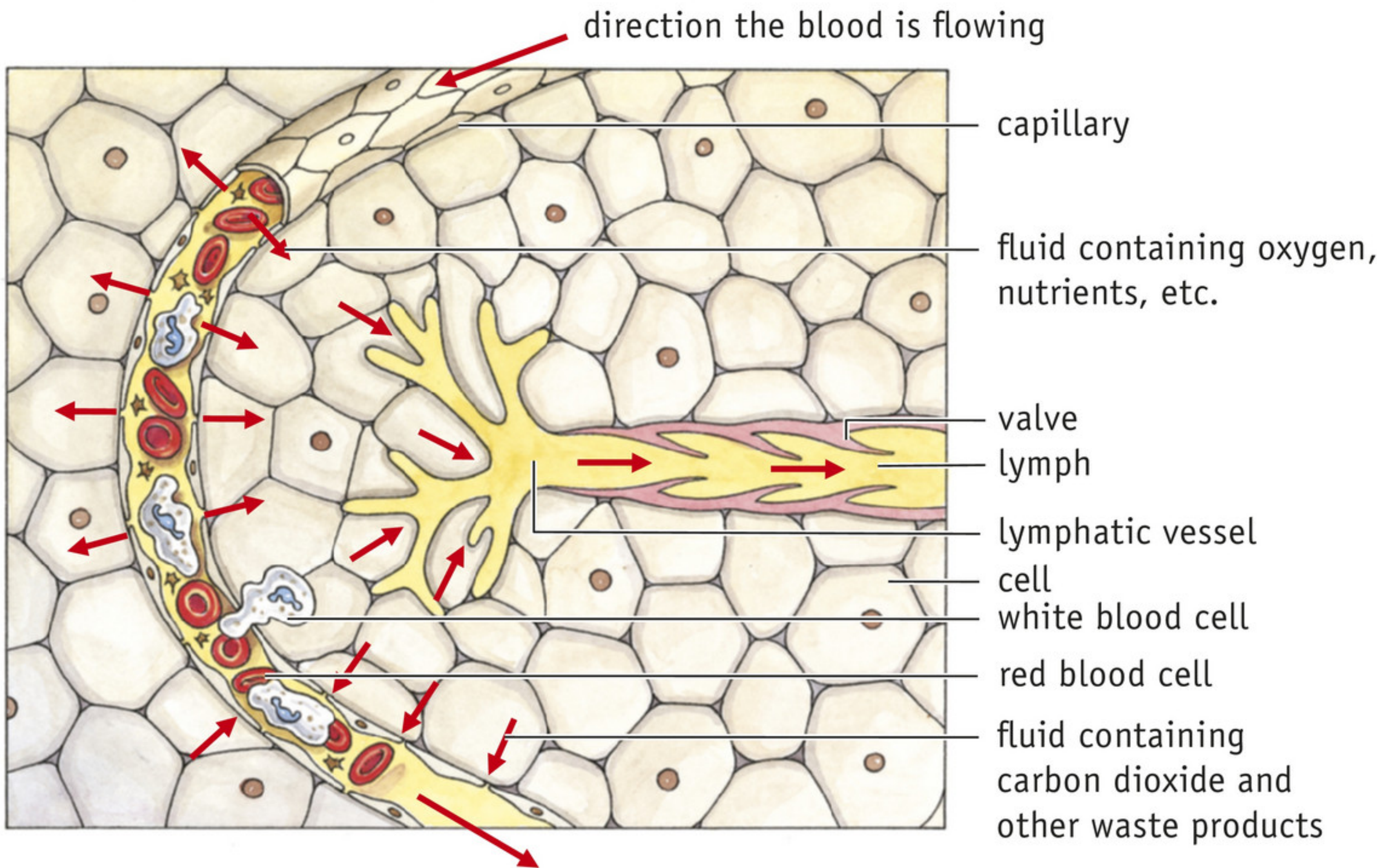
TAXONOMY	LEARNING OBJECTIVE AND EXERCISES
	3.7.13
Remembering	1ab, 5a
Understanding	1c, 2, 5b
Using	3, 4
Analysing	5c

Blood flows through your blood vessels and transports substances to all parts of the body. Some of the fluids from the blood end up outside the blood vessels. There it is called tissue fluid.

TISSUE FLUID

Blood pressure pushes out fluid through the walls at the start of the capillaries. This fluid contains dissolved oxygen and nutrients. Cells absorb some of the oxygen and nutrients. The fluid outside the capillaries is called **tissue fluid**. Tissue fluids can be found between the cells of the organs. Tissue fluids also contain carbon dioxide and other waste products from cells. Tissue fluid is partially reabsorbed into the capillaries (see figure 1).

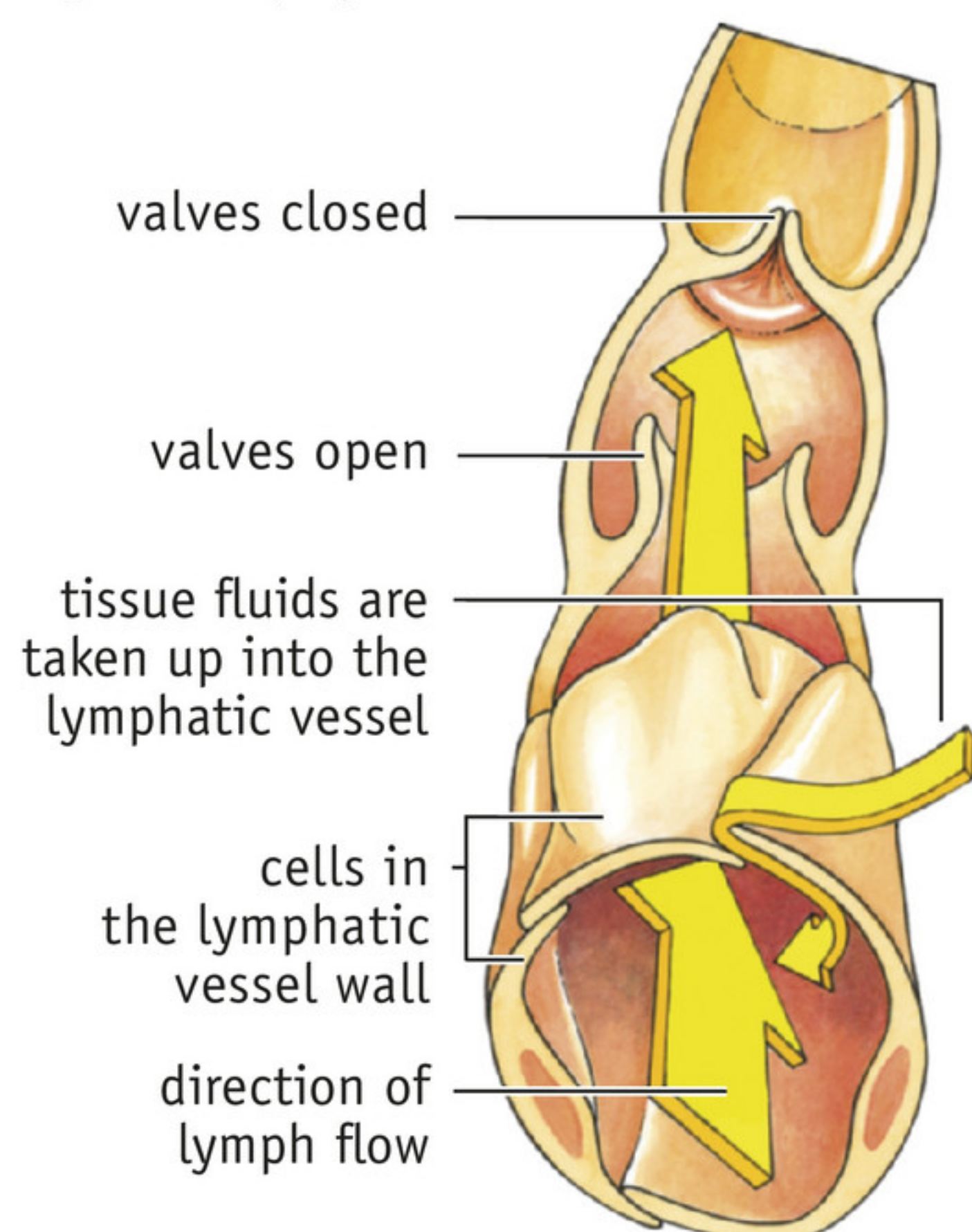
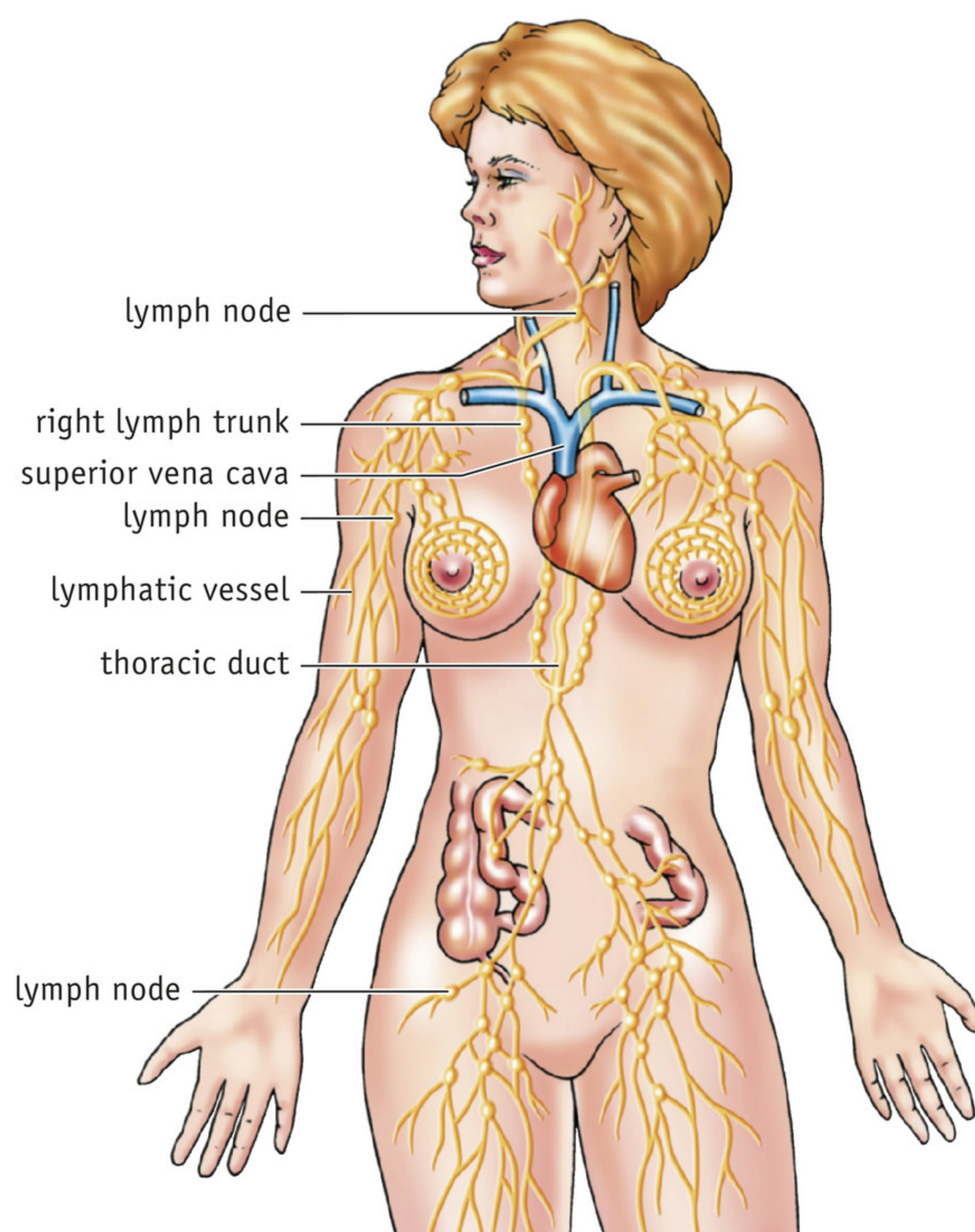
fig. 1 Organ cells with a capillary and a lymphatic vessel.



LYMPH AND LYMPHATIC VESSELS

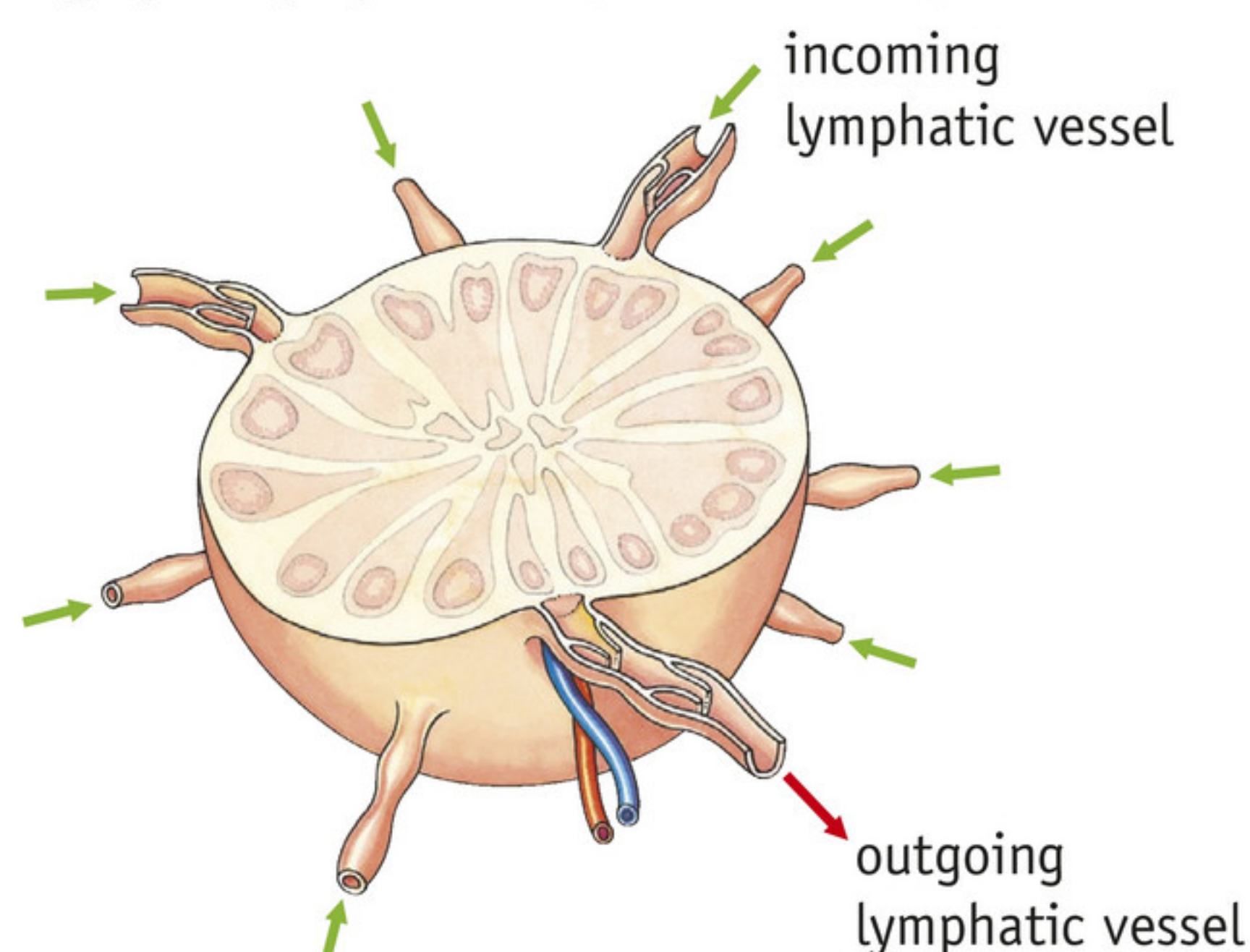
Tissue fluid that is not absorbed by the vessels ends up in very small **lymphatic vessels** (see figure 2). The fluid in lymphatic vessels is known as **lymph**. Lymph consists of water with dissolved substances and white blood cells. Lymph transports carbon dioxide and other waste products away. In addition, lymph contains some of the oxygen and nutrients not absorbed by the cells.

The lymphatic vessels carry the lymph away from the cells in the organs. Valves inside the lymphatic vessels only let lymph flow in one direction.

fig. 2 A lymphatic vessel.**fig. 3** The lymphatic system.

Various small lymphatic vessels converge into larger lymphatic vessels. All the lymphatic vessels together form the **lymphatic system** (see figure 3). Finally, all lymph ends up in two large lymphatic vessels: the right lymph duct and the thoracic duct. These both drain into the veins located below the collarbones (subclavian veins). The lymph flows through these veins into the superior vena cava.

Lymph nodes or lymph glands (see figure 4) are located in certain areas of the body, including in the neck, the armpits and the groin. These lymph nodes purify the lymph, for instance by removing pathogens.

fig. 4 A lymph node (cross-section).

EXERCISES

1

Blood plasma, tissue fluid and lymph are three body fluids.

a What causes fluids to be squeezed out of the systemic circulation's capillaries?

b Where is the fluid located?

- | | | |
|----------------|-----------------------|--|
| A plasma | ☐ | ☐ 1 in blood vessels |
| B lymph | ☐ | ☐ 2 between cells |
| C tissue fluid | ☐ | ☐ 3 in lymphatic vessels |

c What is the function of tissue fluid?

2

Blood transports oxygen, nutrients, carbon dioxide and other waste products.

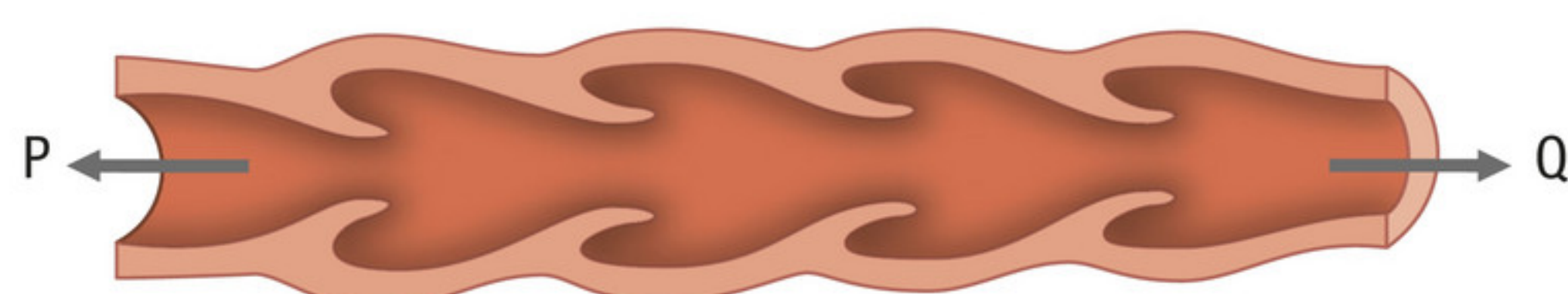
Which of these substances are also found in lymph?

3

Figure 5 is a schematic drawing of a lymphatic vessel.

In which direction is lymph transported in this lymphatic vessel? Explain your answer.

fig. 5



4

An oxygen molecule is in a capillary.

Which parts does the oxygen molecule pass through and in what sequence?

- vein under the collarbone
- thoracic duct
- superior vena cava
- lymphatic vessel
- fluid between the cells

5

a What is the function of the lymph nodes?

b Write down a few locations in your body where lymph nodes occur.

c Someone with a tattoo on their right arm noticed a dark spot in the right armpit after a few years.

Explain why.

 Go to the *Flash cards*.

8 Blood groups

LEARNING OBJECTIVE

3.8.14 You can describe how the blood groups differ.

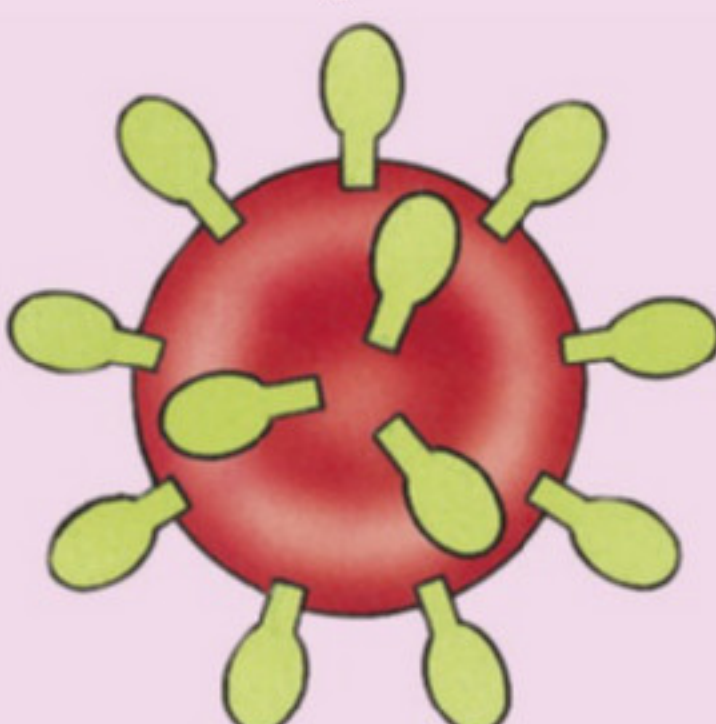
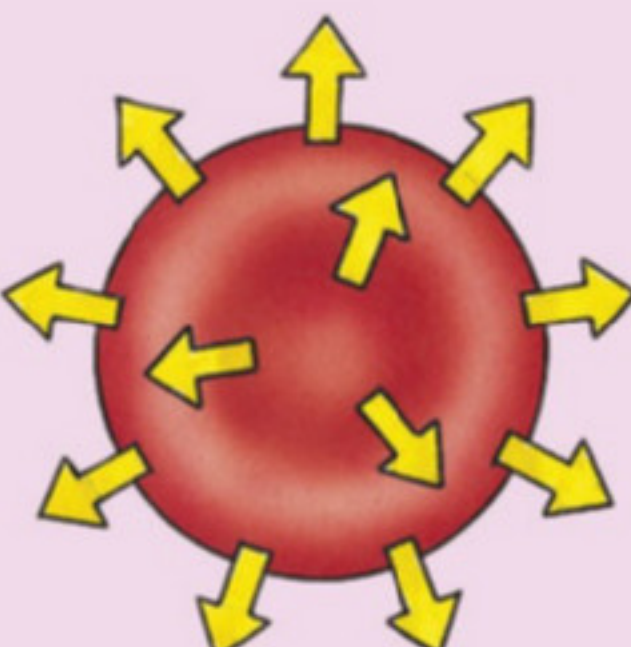
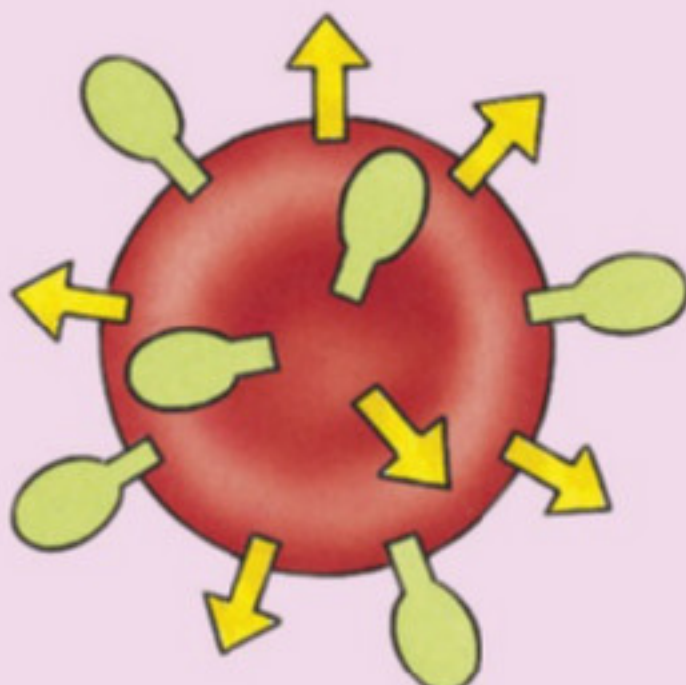
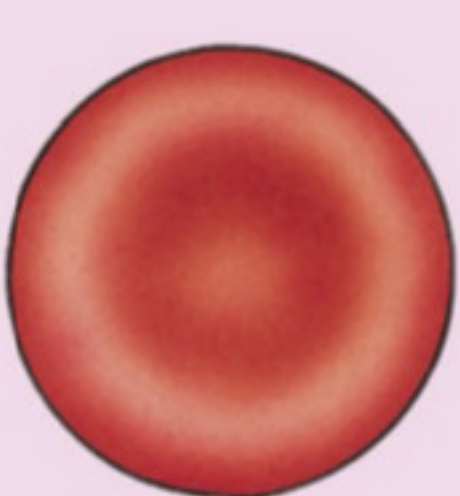
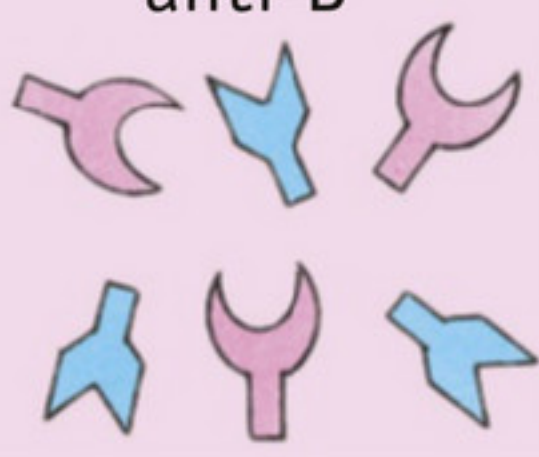
TAXONOMY	LEARNING OBJECTIVE AND EXERCISES
	3.8.14
Remembering	1a
Understanding	1bc, 2, 3, 4a, 5
Using	4b
Analysing	

Certain types of white blood cells make antibodies against pathogens. The blood plasma can also contain antibodies against another person’s blood.

BLOOD GROUPS

Everyone belongs to one particular **blood group**. The most common classification in blood groups is A, B, AB and O (originally a zero, but almost always written as an O now). This classification is based on the antigens that occur on the cell membranes of red blood cells. These antigens are called **blood factors**. Two important blood factors are **antigen A** and **antigen B**. A person with blood group A has antigen A on their red blood cells. Their blood plasma will have antibodies against antigen B (anti-B). Someone with blood group B has antigen B. This person’s blood plasma has antibodies against antigen A, anti-A. Someone with blood group AB has antigens A and B. This person therefore has antibodies to neither factor in their blood plasma. Someone with blood group O has no antigens and therefore both anti-A and anti-B. Figure 1 gives an overview of the blood groups and antibodies.

fig. 1 Blood factors (antigens) and antibodies in the various blood groups.

	Blood group A	Blood group B	Blood group AB	Blood group O
Blood factors on red blood cells	antigen A 	antigen B 	antigen A and B 	no antigen A no antigen B 
Antibodies in blood plasma	anti-B 	anti-A 	no anti-A no anti-B	anti-A anti-B 
% in the Netherlands	43%	9%	3%	45%

BLOOD TRANSFUSION

Someone who has lost a lot of blood in an accident may be given the blood of another person (a donor). This is called a **blood transfusion** (see figure 2). In a blood transfusion, it is important to know which blood group the recipient has and which blood group the donor blood is.

fig. 2 Blood transfusion.



When blood plasma with anti-A comes into contact with red blood cells with antigen A, the red blood cells coagulate (see figure 3). The same happens when blood plasma with anti-B comes into contact with red blood cells with antigen B. The clotted blood cells get stuck in the capillaries. This can damage the brain and kidneys. In figure 4, the red circles indicate that a blood transfusion will go well; the other combinations make the red blood cells clot, which will be the end of them.

fig. 3 Clotting of red blood cells.

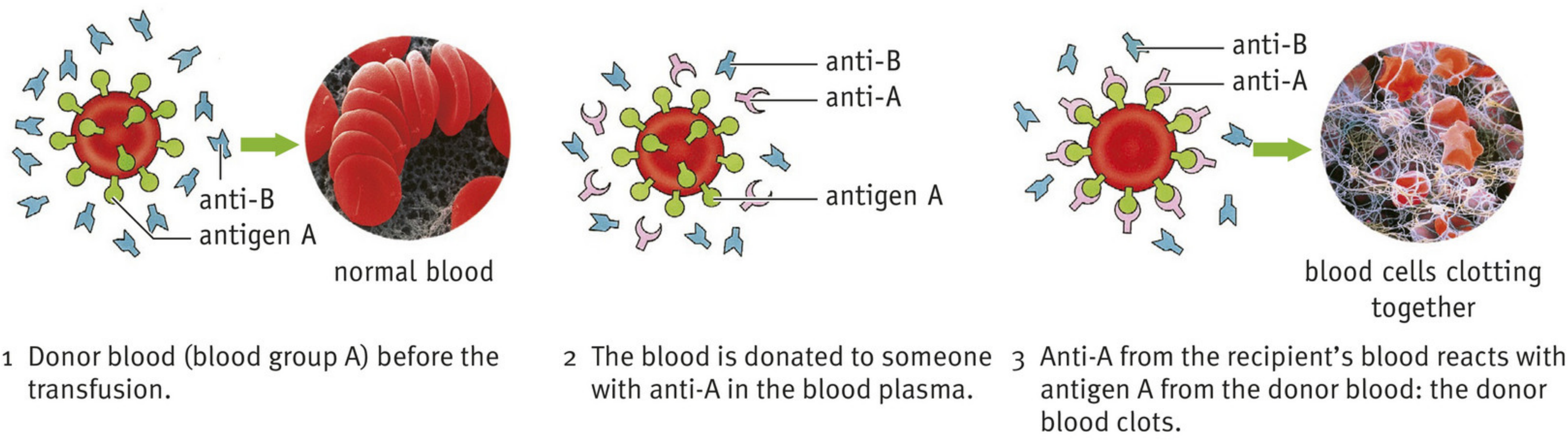


fig. 4 Blood transfusion diagram.

		Blood group of the donor			
		A	B	AB	O
Blood group of the patient (recipient)	A				
	B				
	AB				
	O				

EXERCISES

1

- The four blood groups are A, B, AB and O.
- a Which two blood factors determine your blood group?
- ☐ A anti-A
 - ☐ B anti-B
 - ☐ C antigen A
 - ☐ D antigen B
- b Jasmine has blood group A.
- What is the blood factor on Jasmine's red blood cells?
- ☐ A anti-A
 - ☐ B anti-B
 - ☐ C antigen A
 - ☐ D antigen B
- c What antibody is in her blood plasma? A / B

2

- a** Which blood group has no antigens on the red blood cells?
- ☐ A blood group A
 - ☐ B blood group B
 - ☐ C blood group AB
 - ☐ D blood group O
- b** Which blood group has no antibodies against antigens in the blood plasma?
- ☐ A blood group A
 - ☐ B blood group B
 - ☐ C blood group AB
 - ☐ D blood group O

3

Use figure 4.

- a** Blood from which groups can you administer to a patient with blood group B?
blood group A / B / AB / o
- b** Blood from which groups can you administer to a patient with blood group AB?
blood group A / B / AB / o
- c** Blood from which groups can you administer to a patient with blood group O?
blood group A / B / AB / o
- d** Blood from which groups can you administer to patients with any blood group?
blood group A / B / AB / o
- e** Which blood group must patients be if they can be given blood from any blood group?
blood group A / B / AB / o

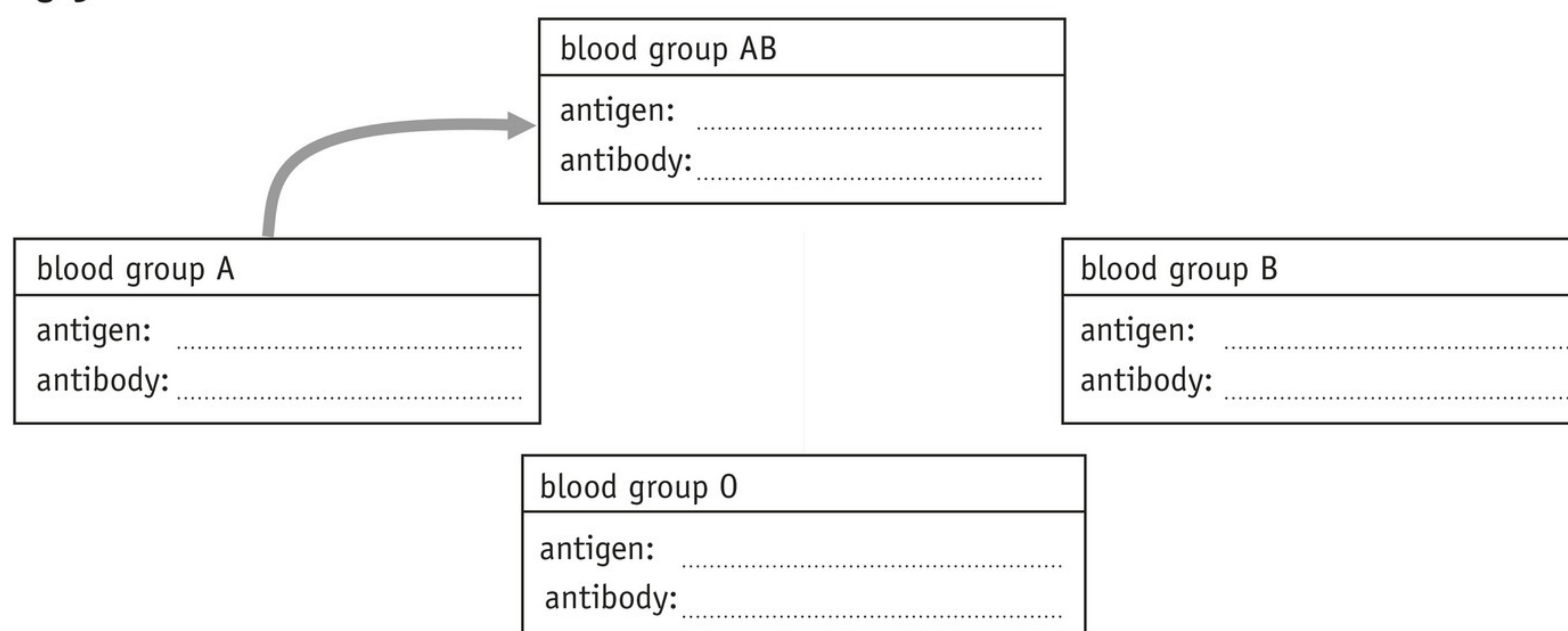
4



Figure 5 is a diagram of blood transfusions.

- a** For each blood group, fill in the antigens on the red blood cells and the antibodies that appear in the blood plasma.
- b** Use arrows to show which blood transfusions are possible. An arrow is shown as an example for the transfusion of donor blood from blood group A to a recipient with blood group AB.

fig. 5



5

- a** blood group AB is called the 'universal recipient'.
Explain why people call it that.
- b** Why is blood group AB the 'universal recipient'?
- c** blood group O is called the 'universal donor'.
Explain why people call it that.
- d** Why is blood group O called the 'universal donor'?

Go to the *Flash cards*.

Learning how to do research

1

DETERMINE THE STUDY TYPE

► Basics 1 | ► Learning objective 3.O.15

TYPES OF STUDIES

There are several types of scientific studies such as:

- experimental research
- descriptive studies
- literature reviews

The type of research that is most appropriate depends mainly on the study question and the purpose of the research.

EXPERIMENTAL RESEARCH

An experimental study lets you examine the effect of a certain factor. You always need a hypothesis: an expectation of what the effect will be. An experimental study aims to test that hypothesis. You do this using one or more test groups and a control group. There is only one factor that differs between these groups: the factor you want to examine the effect of. An example of an experimental study is the effect of light on the germination of watercress seeds. Light is the factor that you want to investigate the effect of.

DESCRIPTIVE STUDIES

In a descriptive study, you record the characteristics of a situation or phenomenon. For example you might study the actions of a hunting owl, or the base sequence of a piece of DNA. Your research consists of describing the characteristics. You can use texts well as drawings, photographs, tables and graphs.

A hypothesis is not needed for descriptive research because you do not know in advance what you are going to observe. An example of a descriptive study is the Human Genome Project. In this study, scientists have tried to describe the complete human DNA genome.

LITERATURE REVIEWS

When you carry out a literature review, you are mostly reading a lot. In a literature review, you collect information from different sources. Examples of sources are articles, books and websites. You are going to assess the information that you have collected. You take a critical look at how useful the information is for answering your study question.

As with a descriptive study, you do not always know exactly what results a literature review will give. That is why this type of research does not need a hypothesis either. An example of a literature review is searching for and assessing sources about a vegan diet (not eating animal products). This lets you explore what experts say about such a diet.

EXERCISES

1

In 2011, research was conducted at 37 Dutch hospitals into the effect of aspirins (painkillers) after a cerebral infarction (stroke). The researchers suspected that aspirin help recovery after strokes because it also helps recovery after a heart attack. The study is summarized in a research table in figure 1.

- a Fill in the purpose, hypothesis and conclusion in the research table (figure 1). Complete the discussion as well.
- b What kind of research is this?
 - ☐ A descriptive study
 - ☐ B experimental research
 - ☐ C literature review

fig. 1

STUDY	THE EFFECT OF ASPIRIN ON CEREBRAL INFARCTIONS		
Aim of the study			
Study question	Does aspirin help recovery after a cerebral infarction?		
Hypothesis			
Working method	This study included 642 stroke patients. Of these, 320 were given only the standard medicine for recovery after a cerebral infarction and 322 patients were also given aspirin. After three months, the percentage of people who had recovered well was measured. 		
Results		Standard medication	Standard medication + aspirin
	Number of experimental subjects	320	322
	Number who had recovered properly	183	174
Conclusion			
Discussion	Does the conclusion match the hypothesis? <i>yes / no</i> The hypothesis <i>has been confirmed / rejected</i>. In the work plan, the test group and the control group were about the same size. This improves the reliability of the results, because		

2

- Read the text ‘Cardiovascular diseases in the Netherlands’ in figure 2. This text shows the causes of death in the Netherlands as the numbers of people who died in 2017.
- a Write down this data in the table.
 - b Work out the percentages for each cause of death. Round each percentage off to a round number. Write the percentages down in the table.
 - c Make a pie chart of the percentages in figure 3. Label the causes of death in (or next to) the sections in the pie chart.
 - d You have used a table and a graph to listed the main groups of diseases that people died from in the Netherlands in 2017.
What type of study is most suitable for this approach?
 - ☐ A descriptive study
 - ☐ B experimental research
 - ☐ C literature review

fig. 2

Cardiovascular diseases in the Netherlands

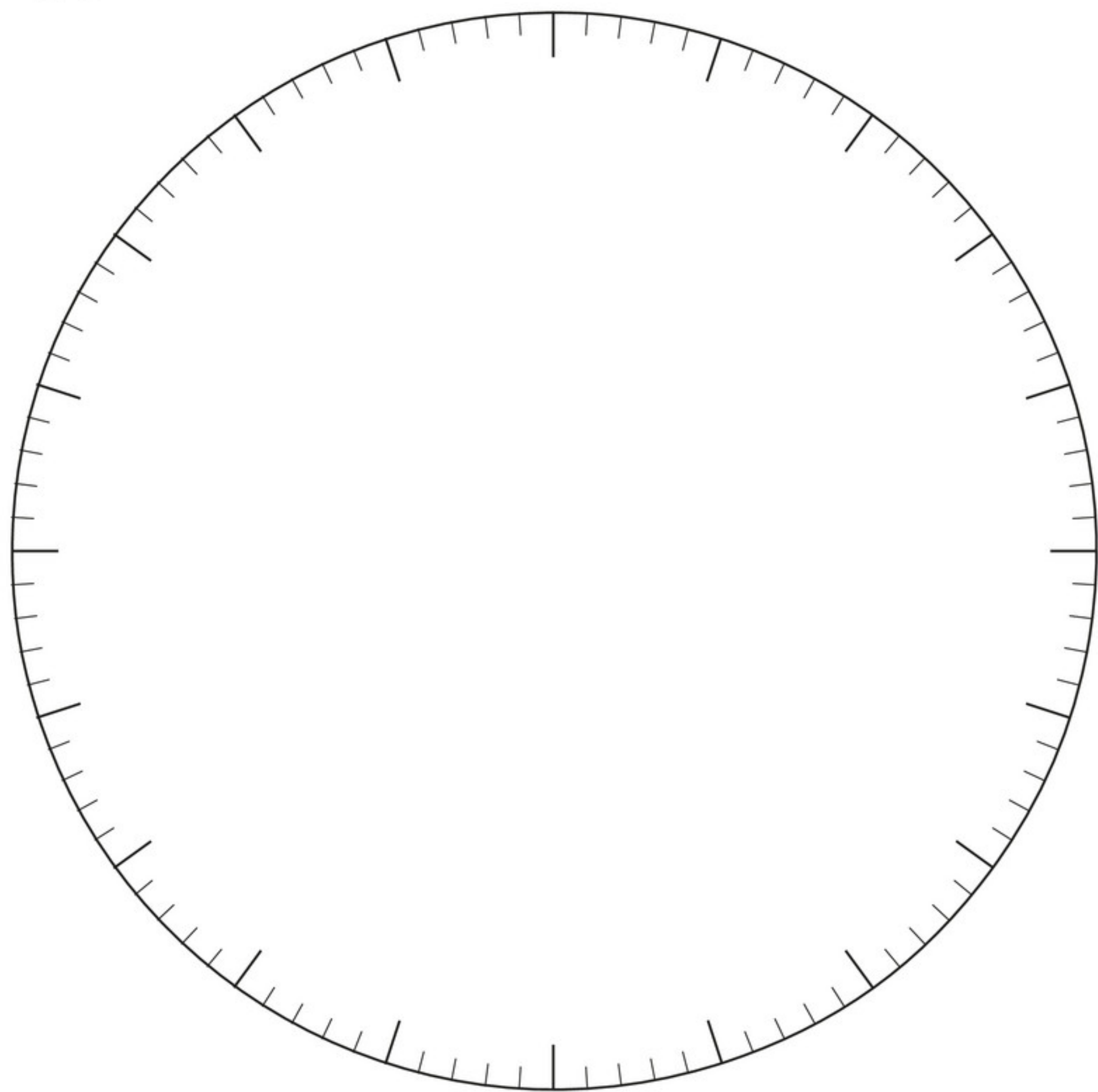
Cancer and cardiovascular diseases are the two key groups of diseases that people died from in the Netherlands in 2017. In that year, 46,556 people died of cancer and 38,153 people died of cardiovascular diseases in the Netherlands. In addition, 12,965 people died of respiratory diseases and 12,598 people died as a result of mental and behavioural disorders. 39,942 people died due to other causes.

Source: Statistics Netherlands.



Causes of death in the Netherlands (2017)	Number of people	Percentage
Cardiovascular disease		
Cancer		
Mental and behavioural disorders		
Respiratory organ diseases		
Other causes of death		
Total		

fig. 3



3

Scientists have known for a long time that drinking too much alcohol is bad for your health. For example, a Finnish study in 2008 looked into the relationship between binge drinking and the risk of a stroke. This study has been summarized in the research table in figure 4.

- a Which two characteristics of an experimental study does this research have?
- b Why is this research not an experimental study? Give two reasons.
- c What type of research is most suitable for this approach?
descriptive study / literature review

fig. 4

STUDY	THE EFFECT OF BINGE DRINKING ON THE RISK HAVING A STROKE		
Study question	Is binge drinking a risk factor for having a cerebral infarction?		
Working method	A group of 15,965 Finnish people (about as many men as women) was divided into frequent binge drinkers and non-binge drinkers. For ten years, both groups were monitored to see how many people had cerebral infarctions. Other factors that may affect the onset of stroke, such as smoking behaviour and diabetes, are also documented. The results are collected using surveys.		
Results		Binge drinkers	Non-binge drinkers
	Number of experimental subjects	3558	12,407
	Number of cerebral infarctions	122	57
	Number of diabetes patients	138	471
	Number of smokers	1945	2690
Conclusion	Regular binge drinking is a risk factor for having a stroke.		

After I. Sundall et al., ‘Increased stroke risk is related to a binge drinking habit’ (2008),
ahajournals.org.

2

LITERATURE REVIEW

► Basics 1 | ► Learning objective 3.O.16

THE STEPS IN A LITERATURE REVIEW

Figure 5 gives an example of a literature review. A literature review is done step by step. First, you decide the purpose of your study and formulate the study question. To find a specific answer to your study question, you will write down **sub-questions**. Together, the answers to the sub-questions will answer the research question.

After that, you make the work plan. In a literature review, the work plan shows what kind of sources you will consult and where you will find them. You carry out your research using your work plan. When doing your research, you look for as many sources as possible. For each source, you determine whether the information is relevant, reliable and current:

- Relevant: does the information help to answer one of my sub-questions?
- Reliable: does the information come from an expert?
- Current: is the information in the source up to date?

When you can answer all your sub-questions, you have found enough sources. Keep track of these sources carefully. You use the sources to answer the sub-questions. Your answers are your results. You use the results to draw a conclusion. Your conclusion is brief; it consists of just a few sentences. Then you write the discussion. In the discussion, you assess how reliable your results are. You do that by checking that everything went according to the work plan. You also check if the work plan was in order.

fig. 5

The steps in a literature review**1 The purpose of the research: what do you want to achieve with your study?**

You know someone who has anaemia. As a result, they are often tired. You want to know more about anaemia. You especially want to know what you can do to avoid getting it yourself. You write down:

The aim of the study is to avoid becoming anaemic.

2 The study question: what do I want to investigate?

You want to know everything you need to know to prevent anaemia. So you ask yourself:

What can you do yourself to protect against anaemia?

3 The sub-questions

You have understood that you need to know several things to prevent anaemia. You want to know what the causes and characteristics are, how to prevent anaemia and how to cure anaemia. You ask the following sub-questions:

- 1 *What are the commonest causes of anaemia?*
- 2 *How can you recognize anaemia in yourself?*
- 3 *What can you do to prevent anaemia?*
- 4 *How can anaemia be cured?*

4 The work plan: what am I going to do?

You only want to use sources that come from experts. That is why you want to ask your doctor for sources. You can also search the Internet for websites. You can write down your work plan as follows:

I call my doctor to ask if he knows good sources about anaemia. I will search for these sources in the library or on the internet.

On the internet, I will also look for websites with information about anaemia. These websites must have been written by experts.

5 Doing the study: which sources should I store?

You carry out your research according to your work plan. For each source, you will assess whether it is relevant, current and reliable.

Suppose for example that you find two websites on the internet that are about anaemia. The first website is written by a doctor, the second website by a student. You conclude that only the first website is reliable, because it comes from an expert. That is why you only use the first website.

You also find an article about anaemia on the internet. You see that this article was written in 1980. You reckon that this article is probably outdated and decide not to use it.

6 The results: what are the answers to the sub-questions?

You look at the sources you have saved and use them to answer the four sub-questions. For sub-question 2, for example, you can write down:

The most common characteristics of anaemia are:

- *you get tired quickly;*
- *you feel weak all the time;*
- *your heart beats fast;*
- *you are often dizzy;*
- *you often get headaches.*

7 The conclusion: what is the answer to the study question?

You use the answers to the sub-questions to draw the conclusion. Your conclusion could be:

Anaemia is usually caused by low iron and/or vitamin B12 levels in your body. You can prevent this by eating foods that contain iron and/or vitamin B12. If you get tired quickly and you feel weak all the time, you may be anaemic. If you have several symptoms of anaemia, you should see your doctor.

8 The discussion: how reliable are my results?

Your doctor was on holiday and you couldn't ask him for any sources. So you only searched the internet for sources. On the internet, you managed to find four sources to answer the sub-questions. You were unable to determine who wrote one of the sources. You could write down the conclusion as follows:

The study did not go quite according to the work plan. I could not speak to the doctor because he was on holiday. So I could not ask him for sources. I have found four sources on the internet to answer all four sub-questions. Three of the sources were relevant, reliable and current. One source was relevant and current, but not completely reliable. There was no author mentioned, so I do not know if it was written by an expert. Everything else went according to the work plan. The work plan was fine. The results are reliable because almost all the sources are written by experts.

PRESENTING A LITERATURE REVIEW IN WRITING

Figure 6 tells you how to write a research report based on a literature review.

When you use information from a source in the report, you refer to that source in the text.

You give the authors and the year that the source was published. All the sources you use in the report are put at the end of your report. This is called the **literature list**. Figure 7 shows what you need to document for each source in the literature list.

fig. 6

Writing a literature review report

- 1 Give your study a title.
Put your name and the names of the people you have been working with under the title.
- 2 Write an introduction.
Here you will describe:
 - the subject you wanted to investigate;
 - what the purpose of your study is.You can also explain the subject in more detail.
- 3 Then you make sections in the report for each of the research steps.
 - study question (and sub-questions)
 - work plan
 - results
 - conclusion
 - discussion
- 4 Add the literature list at the end of your report.
The literature list contains all the sources that you used for information.

fig. 7

What do you put in the literature list?

For a book:

- the title
- the author (or authors)

For an article:

- the title of the article
- the name of the author (or authors)
- the title of the journal or newspaper

For a website:

- the title of the article
- the name of the author (or authors)
- a link to the web page

EXERCISE

1

You are going to think up and carry out a literature review and present it as a written report. The subject of your research can fit in with the theme 'The circulation', but it may also be about something else. Your teacher will tell you.

- Think what you want to investigate. Discuss with your teacher whether that is a reasonable choice.
- Write down the study question and the sub-questions.
- Make a work plan. The work plan contains:
 - what kinds of sources you will consult
 - where you are going to look for the sources
- Get your teacher to check the study question, the sub-questions and the work plan.
- Carry out the study according to the work plan.
- Write down the results for each sub-question.
- Write down a conclusion that answers the research question.
- Make a report of the study.

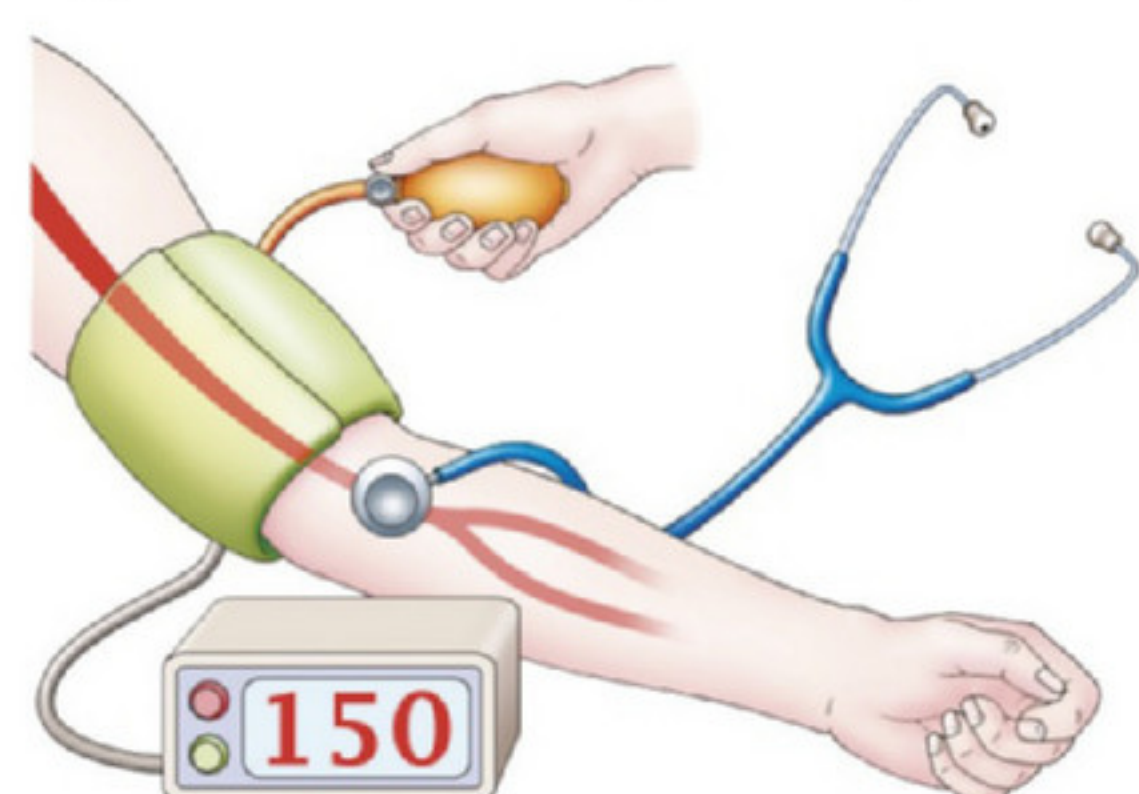
3

MEASURING BLOOD PRESSURE

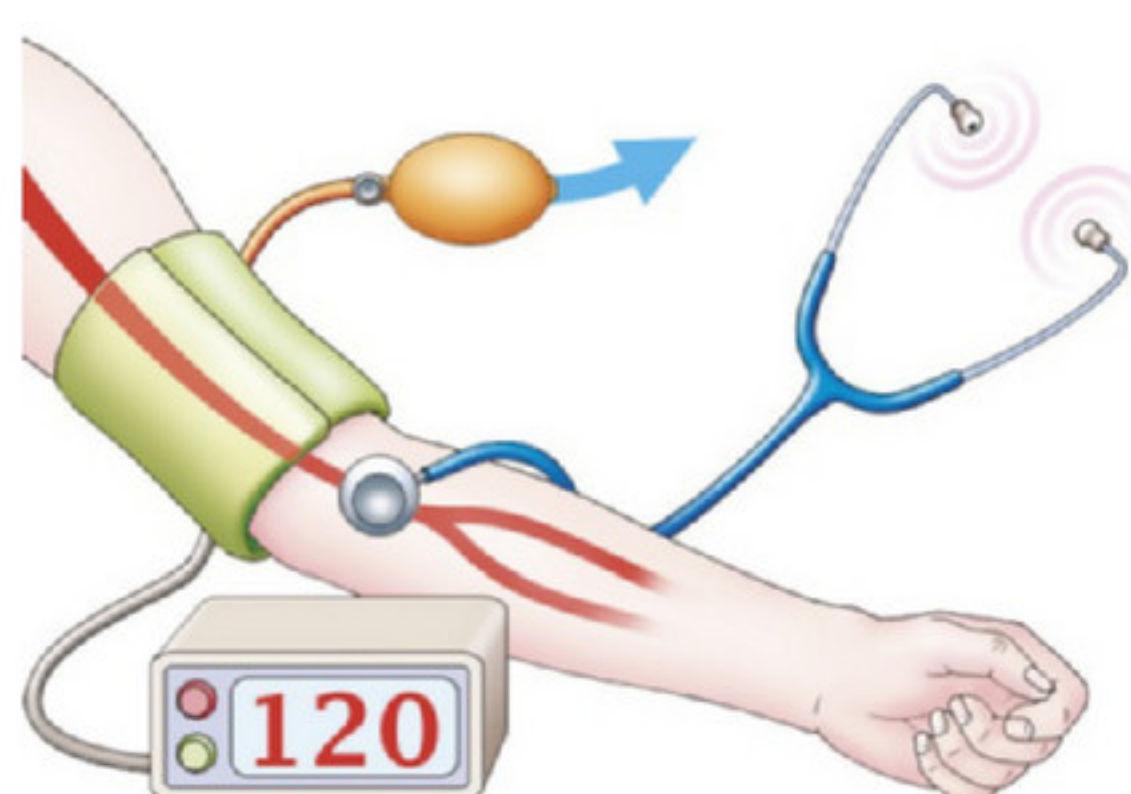
► Basics 6 | ► Learning Goal 3.0.17 | ► Practical activity 2

Many people have their blood pressure taken, often by a doctor. They do this to check that their blood pressure is not too high or too low. The blood pressure is highest during contractions of the ventricles. This is called the systolic pressure. The blood pressure is lowest during relaxation of the ventricles. This is called the diastolic pressure. Figure 8 shows how to measure blood pressure.

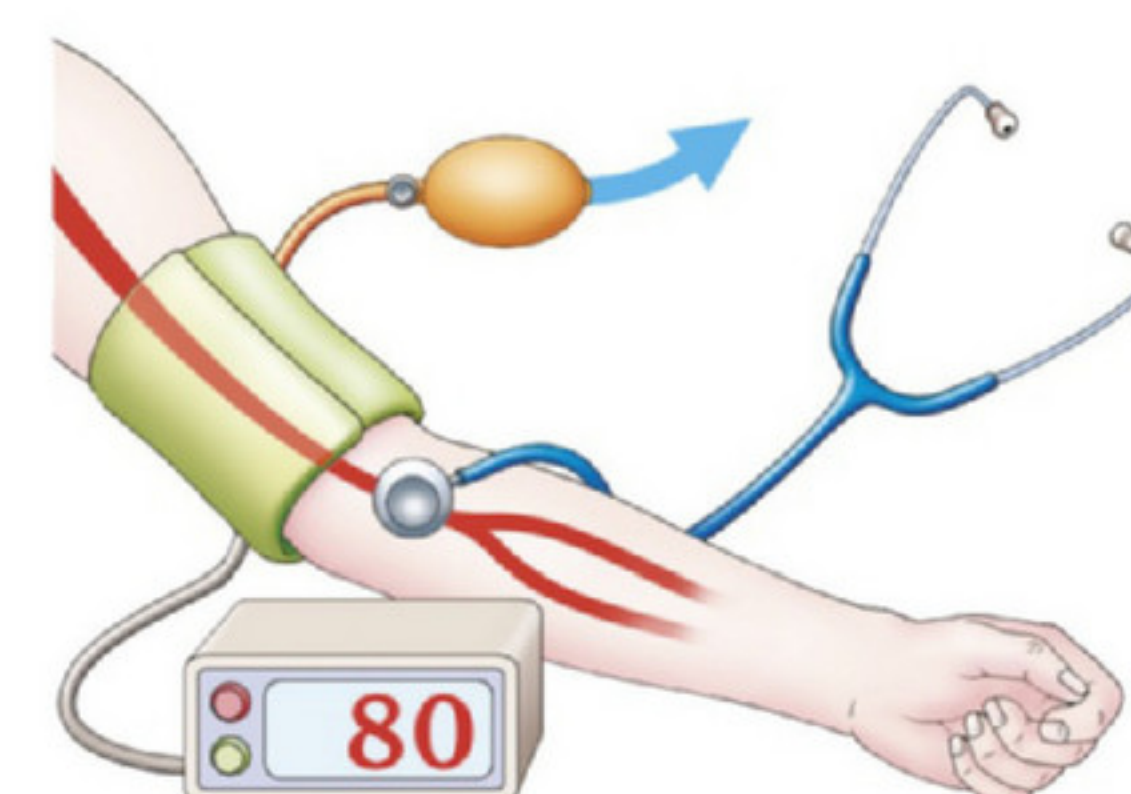
fig. 8 Measuring blood pressure.



1 The cuff is pumped up to a pressure that is greater than the highest blood pressure in the brachial artery.



2 Air escapes from the cuff until the artery begins to pass a small amount of blood at each heartbeat: the doctor reads off the systolic pressure.



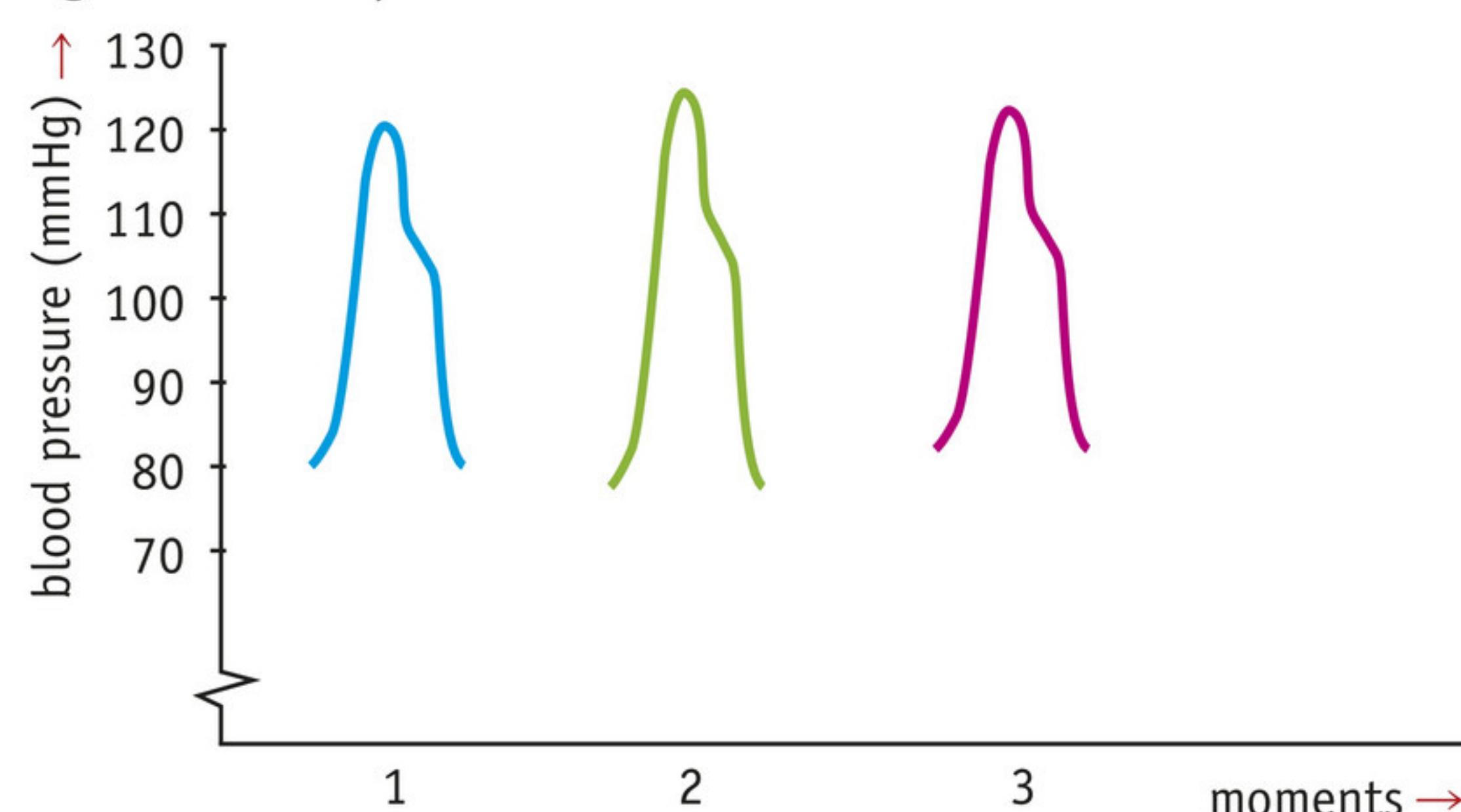
3 So much air has escaped that the blood flow through the brachial artery is constant: the doctor reads off the diastolic pressure.

Digital blood pressure meters let you check your blood pressure at home (see figure 9). Blood pressure is measured in mmHg (millimetres of mercury). The average systolic pressure is 120 mmHg and the average diastolic pressure is 80 mmHg (see figure 10).

fig. 9 A digital wrist blood pressure meter.



fig. 10 Blood pressure measurements at three times.



EXERCISES

1

In a blood pressure measurement, the systolic and diastolic pressures are both measured.

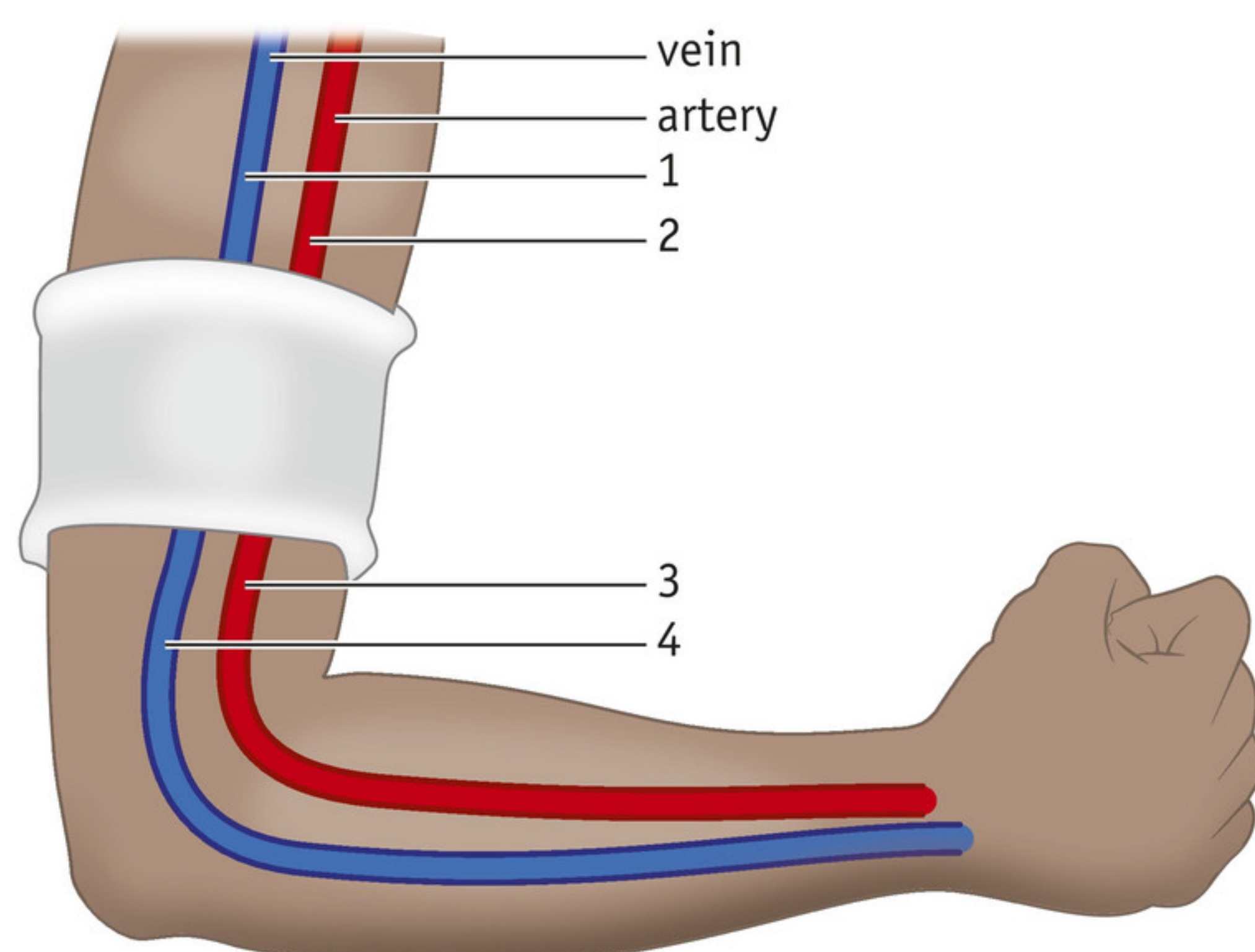
- a** What makes the blood pressure in an artery vary so much?
- b** Which pressure is associated with contraction of the left ventricle?
systolic / diastolic

2

A doctor does a blood pressure measurement on a patient. The doctor has put the cuff around the upper arm and pumped it up (see figure 11).

- a** The doctor has not yet begun to gradually deflate the cuff.
Could you feel a pulse just now at the wrist of the arm where the blood pressure is being measured? Explain your answer.
- b** The doctor then gradually deflates the cuff.
At which of the places labelled in figure 11 will the blood pressure first increase? Explain your answer.

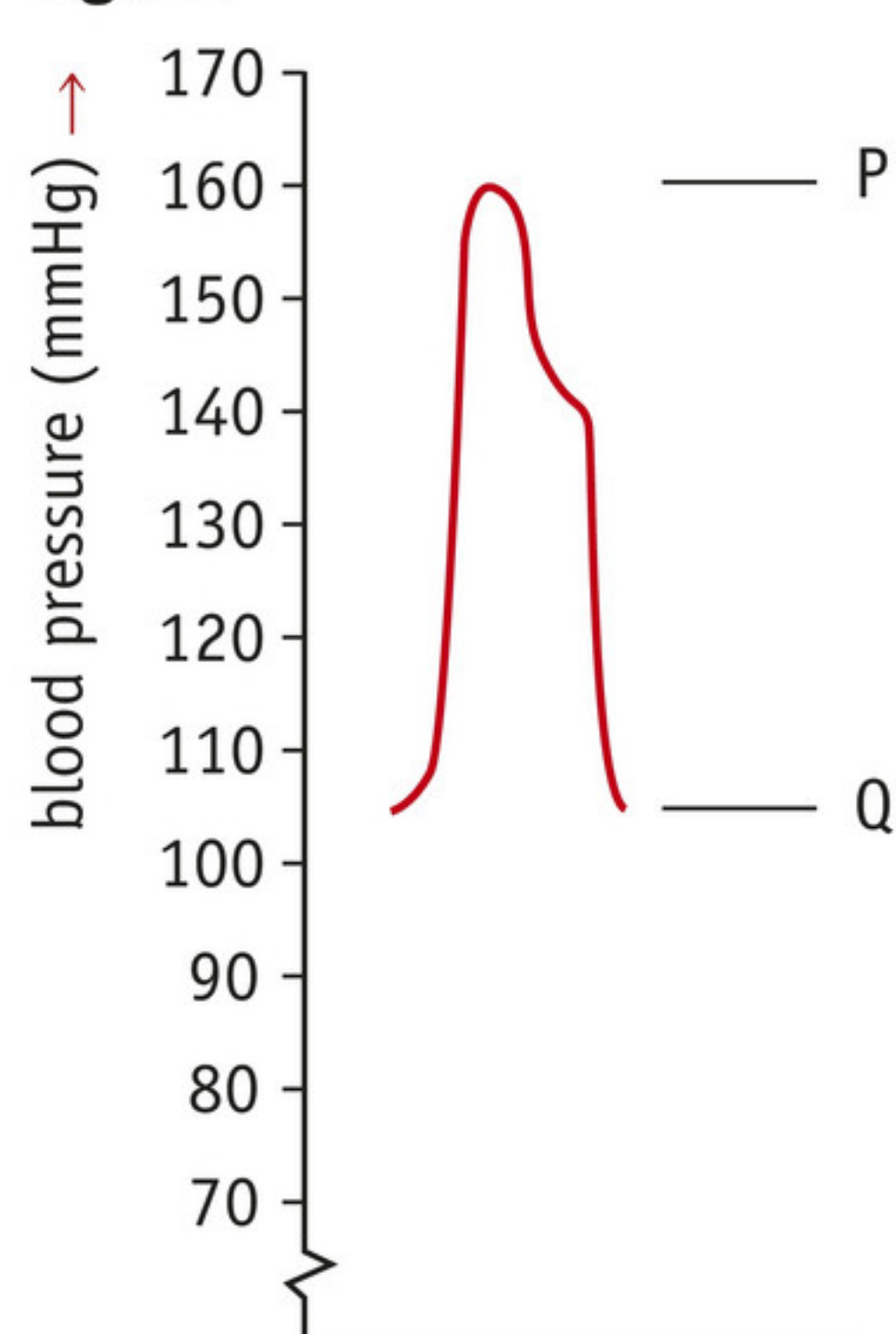
fig. 11



3

- a** The diagram in figure 12 shows the blood pressure of Marie-Claire (aged 27).
Which letter shows Claire's diastolic pressure? *P / Q*
- b** Compare Marie-Claire's systolic pressure with the average adult systolic pressure.
What is your conclusion?

fig. 12



Practical activities

1

BLOOD CELLS

► Basics 1 | ► Learning objective 3.1.1

 15-25 minutes

WHAT ARE YOU GOING TO DO?

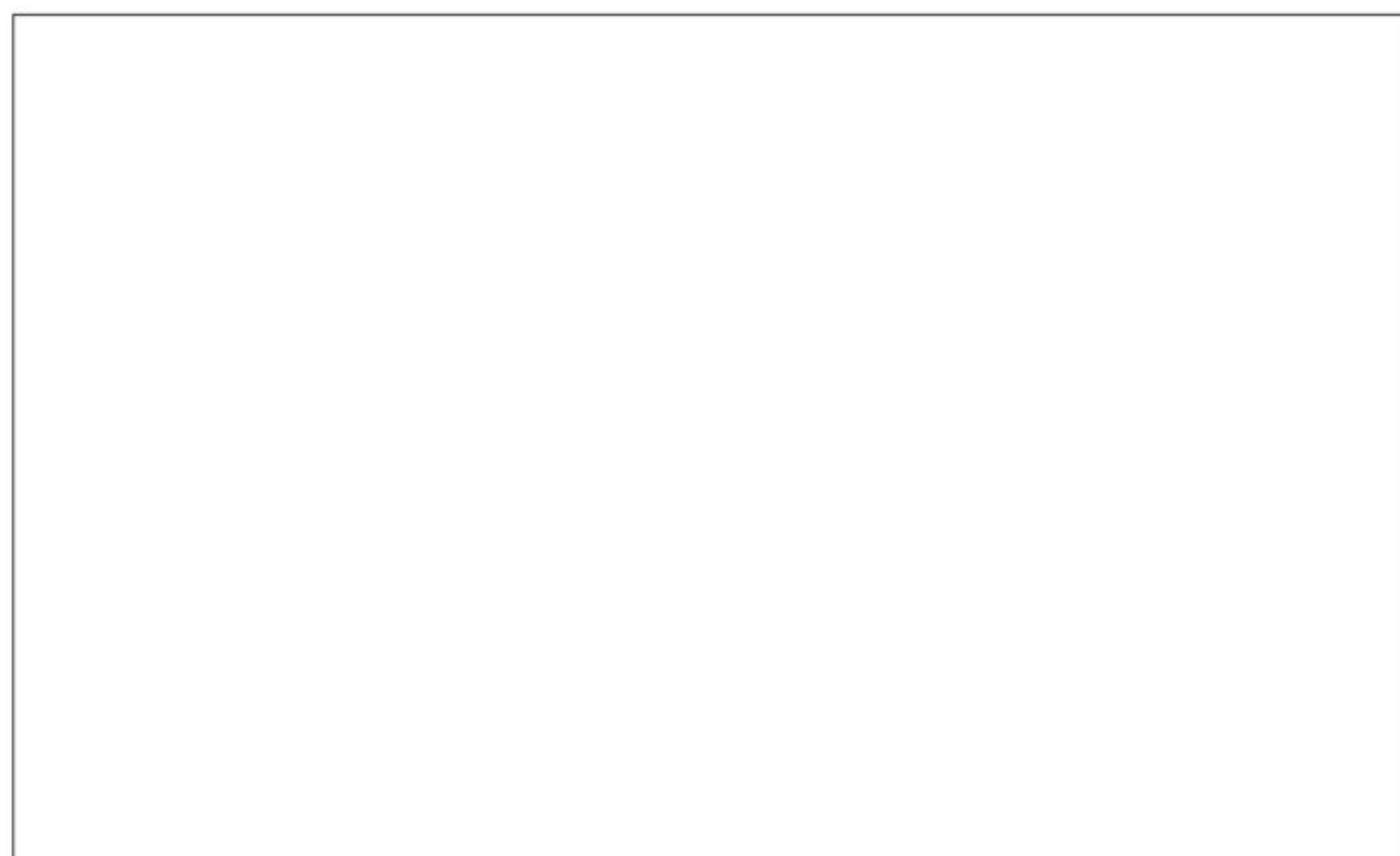
In this practical activity, you will be looking at red and white blood cells under a microscope. You will make drawings of the blood cells.

WHAT DO YOU NEED?

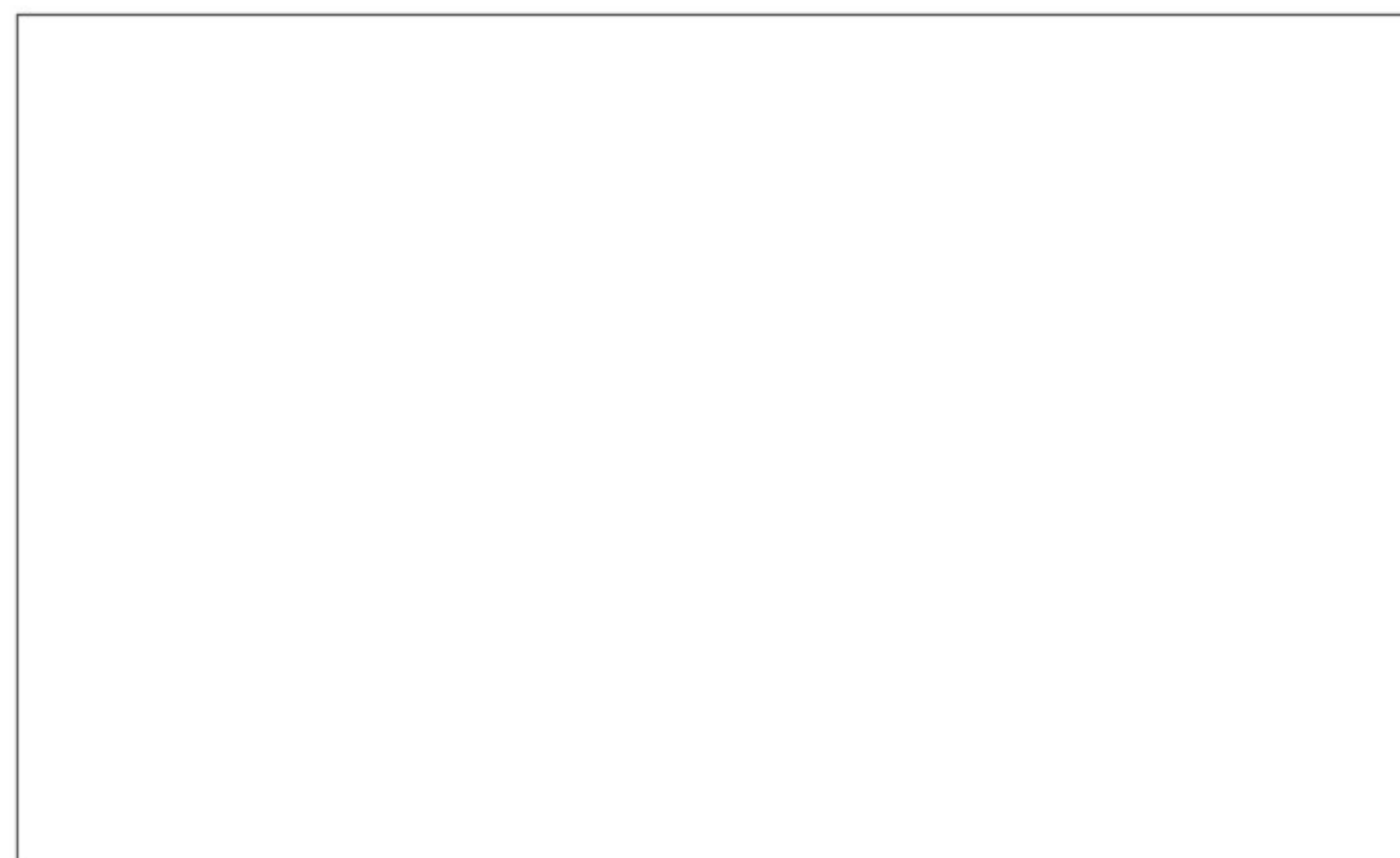
- ☐ a specimen slide of a blood sample
- ☐ a microscope
- ☐ drawing materials

WORKING METHOD

- Examine the slide at a magnification of 100×. Find a part of the slide that shows both red and white blood cells.
- Examine the slide at a magnification of 400×.
- Make a drawing of a red blood cell and a drawing of a white blood cell. Write *red blood cell* – *white blood cell* under the drawing. Label the *nucleus* in the white blood cell.



.....



.....

2

BLOOD PRESSURE MEASUREMENT

► Basics 6 | ► Learning objective 3.O.17 | ► Learning how to do research 3

 15-20 minutes

WHAT ARE YOU GOING TO DO?

In this practical activity, you work with a classmate whose blood pressure you will measure.

WHAT DO YOU NEED?

- ☐ a blood pressure meter (see figure 1)

WORKING METHOD

- Measure your classmate’s blood pressure. The blood pressure meter manual describes how to use the device (see also ‘Learning how to do research 3’).
- Then get your classmate to measure your blood pressure.
- Write down your systolic pressure and diastolic pressure.

systolic pressure	mmHg
diastolic pressure	mmHg

- Get your teacher to check the measurements.

fig. 1 Blood pressure meters.



Summary

BASICS 1

BLOOD

1 You can name the components of blood with their features and functions.

- Blood consists of blood plasma (about 55%) and blood cells and platelets (about 45%).
- Blood plasma: water with plasma proteins (such as fibrinogen) and dissolved substances (including salts).
 - Blood plasma transports oxygen (to a small extent), nutrients, antibodies, carbon dioxide and other waste products.
 - Fibrinogen plays a role in clotting.
- Red blood cells:
 - Cells without nuclei.
 - Red cells contain the red pigment haemoglobin.
 - Function: transporting oxygen.
 - Anaemia: the blood contains too little haemoglobin. This can make you feel weak and tired all the time.
- White blood cells:
 - Cells with nuclei.
 - White blood cells do not have a fixed shape; they can pass through the capillaries' walls.
 - Function: protection against pathogens, for instance by encapsulating bacteria.
- Platelets:
 - Fragments of cells that have broken up, with no nuclei.
 - Function: coagulation.

BASICS 2

THE CIRCULATORY SYSTEM

2 You can name three types of blood vessels with their features and functions.

- Arteries:
 - blood flows through them and away from the heart
 - high blood pressure
 - thick, tough and elastic walls
 - noticeable 'pulse', e.g. in the wrists
 - usually located deeper inside the body
 - the only valves are the semilunar valves (at the start of the pulmonary artery and the aorta)
- Capillaries:
 - Walls one cell layer thick.
 - White blood cells and fluid with oxygen, nutrients and waste products (including carbon dioxide) can get through the walls.
- Veins:
 - blood flows through them back towards the heart
 - low blood pressure
 - thin walls
 - no noticeable 'pulse'
 - usually lie nearer the surface of the body
 - valves keep the blood from flowing back (especially in the arms and legs)

3 You can name arteries and veins in the human circulatory system.

- Pulmonary circulation: pulmonary arteries – pulmonary veins.
 - Deoxygenated blood flows through pulmonary arteries.
 - Oxygen-rich blood flows through pulmonary veins.
- Systemic circulation: aorta – brachial arteries – brachial veins – carotid arteries – carotid veins – hepatic artery – hepatic vein – mesenteric artery – portal vein – renal arteries – renal veins – femoral arteries – femoral veins – inferior vena cava – superior vena cava.
 - Oxygen-rich blood flows through arteries.
 - Deoxygenated blood flows through veins.
 - Deoxygenated blood flows from the walls of the intestinal tract through the portal vein to the liver.

4 You can distinguish between the pulmonary and the systemic circulation and their functions.

- Double circulatory system: in each complete circuit, the blood passes through the heart twice.
- Pulmonary circulation: heart – lungs – heart.
 - Function: absorbing oxygen into the blood and releasing carbon dioxide to the air.
- Systemic circulation: heart – rest of the body – heart.
 - Function: to release oxygen and nutrients to the cells, and to absorb carbon dioxide and other waste in the blood.

BASICS 3

THE HEART**5 You can name the parts of the heart and the blood vessels connected to it, with their features and functions.**

Parts	Characteristics and functions
Superior and inferior vena cava	transport deoxygenated blood from the organs to the heart
Right atrium	• receives deoxygenated blood from the venae cavae and passes it to the right ventricle • the wall is less muscular
Right ventricle	• pumps oxygen-poor blood into the pulmonary artery • muscular wall
Pulmonary arteries	transport deoxygenated blood from the heart to the lungs
Pulmonary veins	transport oxygen-rich blood from the lungs to the heart
Left atrium	• receives oxygen-rich blood from the pulmonary veins and passes it to the left ventricle • the wall is less muscular
Left ventricle	• pumps oxygen-rich blood into the aorta • very muscular wall
Aorta	transport oxygen-rich blood from the heart to the organs
Cardiac septum	partition between the left and right halves of the heart
Heart valves	• valves between atria and ventricles • prevent the blood from flowing back from the ventricles to the atria
Semilunar valves	• valves at the entrances to the pulmonary artery and the aorta • prevent the blood from flowing back from the pulmonary artery and aorta into the atria
Coronary arteries	• branch off the aorta • carry blood that is rich in oxygen and nutrients (such as glucose) to the heart muscle
Coronary veins	transport blood that is rich in carbon dioxide and other waste products away from the heart muscle

6 You can describe the progress of a heartbeat.

- Contraction of the atria.
 - The atria contract. This makes blood flow into the ventricles.
 - The heart valves are open, the semilunar valves are closed.
- Contraction of the ventricles.
 - The ventricles contract.
 - The heart valves close.
 - Pressure in the ventricles increases.
 - The semilunar valves open.
 - The blood gets pumped into the pulmonary arteries and the aorta.
- Cardiac pause:
 - Both the atria and the ventricles relax.
 - Blood flows from the vena cava and pulmonary veins into the atria and ventricles.
 - The heart valves are open, the semilunar valves are closed.

BASICS 4

EXCRETION**7 You can name the parts of the kidneys and urinary tract with their features and functions.**

- From the outside inwards, kidneys consist of the renal cortex, renal medulla and renal pelvis.
 - Function: removing waste, excess water, excess salts and harmful substances from the blood. The eliminated substances together are called urine.
 - The renal cortex and renal medulla produce the urine.
 - The urine is collected in the renal pelvises.
- Ureters: drain the urine from the kidneys to the bladder.
- Bladder: temporary store for the urine.
- Urethra: tube that lets the urine leave the body.

BASICS 5

THE IMMUNE SYSTEM**8 You can describe how antibodies protect against infection.**

- Antigens (exogenous or foreign substances): substances that do not belong in the body.
 - There are antigens on the surface of pathogens.
- Infection: pathogens get into the body.
 - A certain type of white blood cell produces antibodies against the pathogen's antigens.
 - Antibodies attach themselves to antigens on the surface of the pathogen. The pathogen gets covered with antibodies. This disables the pathogen.
 - Any given type of antibody can only attach itself to one type of antigen.

9 You can describe how immunity arises.

- Immunity: after an infection, the antibody against the pathogen remains present in the blood or can be created quickly in the event of a new infection. Symptoms of illness don't appear.
 - Natural immunity: this is created when a person experiences the disease, for instance chickenpox.
 - Artificial immunity: a vaccination (inoculation) with a vaccine creates artificial immunity. A vaccine contains a dead or weakened (attenuated) pathogen.

10 You can describe what happens in the event of an allergic reaction.

- Allergy: hypersensitivity to one or more substances.
 - You can be allergic to household dust, animal hair, certain substances in food, and so on.
 - Allergic reactions occur when the body comes into contact with these substances.
 - Allergic reactions can include a rash, a burning sensation, itching or inflammation.

BASICS 6

HEALTHY LIFESTYLES

11 You can describe how to keep your heart and blood vessels healthy.

- Blood pressure: the pressure that the blood exerts on the walls of the arteries.
 - Causes of high blood pressure include stress, smoking, obesity and eating salty food.
 - Long-term high blood pressure damages the arterial walls.
- Arteriosclerosis: constriction of blood vessels.
 - cause: damage to the vessel wall
 - effect: higher blood pressure, reduced blood flow to the organs and possibly overexertion of the heart
 - reducing the risk of arteriosclerosis: not smoking, eating healthily and exercising regularly
- Myocardial infarction (heart attack): part of the heart muscle is no longer being supplied with oxygen and nutrients.
 - Cause: a coronary artery or its branch has become clogged (usually due to arteriosclerosis).
 - Consequence: part of the heart muscle dies off. This can be fatal.
- Cardiovascular diseases: the collective name for diseases of the heart and blood vessels.
 - Hereditary factors play a role in the development of cardiovascular diseases.
 - Tension and stress increase the risk of high blood pressure and cardiovascular disease.
- You can reduce the risk of getting cardiovascular diseases by adopting a healthy lifestyle.
 - do not smoke
 - do not drink alcohol (adults: alcohol in moderation)
 - eat a healthy and varied diet (with few fatty foods and not much salt)
 - exercise regularly (at least half an hour a day)
 - avoid stress and make sure you relax enough

12 You can name the effects of alcohol in the short term and in the long term.

- Alcohol affects the functioning of the nervous system and behaviour.
 - The powers of perception and ability to react will decrease temporarily.
- Young people are extra sensitive to the effects of alcohol and therefore:
 - have a higher chance of permanent brain damage
 - have a higher risk of addiction
- Hangover: headache and extreme thirst after consuming too much alcohol.
- A few short-term consequences of alcohol consumption:
 - 1 to 2 glasses (0 to 0.5‰): stimulated, alert, relaxed, cheerful, more appetite, heart rate and respiration accelerate, the blood vessels widen
 - 2 to 7 glasses (0.5 to 1.5‰): self-overestimation, natural inhibitions decrease, memory decreases, reaction speed decreases, dangerous in traffic
 - 6 to 14 glasses (1.5 to 3‰): muscle control decreases, emotions become stronger, self-criticism disappears, face turns red, risk of blacking out
 - more than 10 to 15 glasses (3 to 4‰): senses get numbed, a person gets confused, the perception is disturbed
 - 4‰ and above: respiration and heart rate slow down, risk of coma and death
- Alcohol poisoning: losing consciousness due to too much alcohol.
 - In young people, this can happen at just 1.7‰ (seven glasses).
 - Organs and the brain can be seriously damaged.
- Binge drinking: drinking a lot of alcohol in a short time, which increases the blood alcohol content to 0.8 promille (‰) or more.
- A few long-term consequences of alcohol consumption:
 - disrupted brain development
 - hormone imbalance
 - damage to the liver, stomach and heart
 - memory loss and reduced school, study and work performance

EXTRA 7

TISSUE FLUIDS AND LYMPH

13 You can name the characteristics and functions of tissue fluid and lymph.

- Tissue fluid: is created by fluids being forced out of the vessels due to the blood pressure. This transports oxygen and nutrients to the cells and carries away carbon dioxide and other waste products. Also contains white blood cells.
- Lymph: tissue fluid that is taken up into lymphatic vessels. Contains white blood cells, oxygen, nutrients, carbon dioxide and other waste products.
 - Small lymphatic vessels converge to produce large lymphatic vessels. Lymphatic vessels have valves.
 - The lymphatic system transports the lymph back to the circulatory system through the right lymph trunk and thoracic duct.
 - Lymph nodes purify the lymph, for instance by removing germs.

EXTRA 8

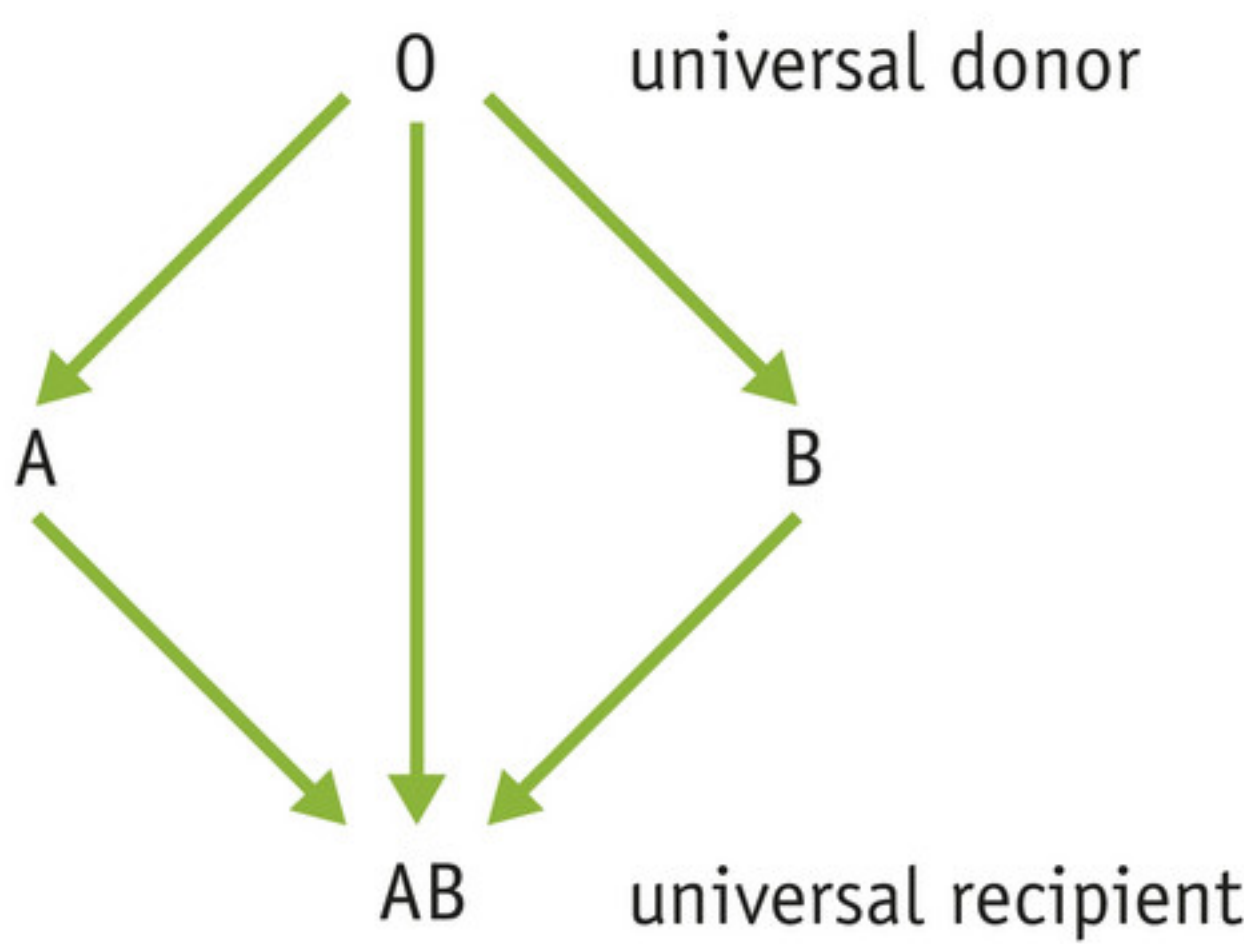
BLOOD GROUPS

14 You can describe how the blood groups differ.

- Blood groups (A, B, AB, O) differ in terms of blood factors and antibodies.
 - Blood factor: substance on the cell membrane of red blood cells that acts as an exogenous substance (antigen) for someone who does not have this substance.
 - Important blood factors are antigen A and antigen B.
 - The blood plasma contains antibodies to the antigens that are not on the body’s own red blood cells.

Blood group	Blood factor on red blood cells	Antibodies in blood plasma
A	antigen A	anti-B
B	antigen B	anti-A
AB	antigen A and antigen B	none
o	none	anti-A and anti-B

- Blood transfusion: the administration of blood from another person.
 - Possible blood transfusions:



- In other cases, the antibodies of the recipient react to the antigen in the donor blood (e.g. anti-A with antigen A). Red blood cells clot and die.

RESEARCH

LEARNING HOW TO DO RESEARCH AND PRACTICAL ACTIVITIES

- 15 You can determine which type of study is the most appropriate.
- 16 You can carry out a literature review.
- 17 You can measure someone else’s blood pressure.

 Go to the *Flash cards* and the *Diagnostic test*.

Glossary

A

abdominal breathing (diaphragmatic breathing)

buikademhaling

Ademhaling waarbij het middenrif en de buikwand bewegen.

additive additief

Stof die toegevoegd wordt aan voedingsmiddelen om ze langer houdbaar of aantrekkelijker te maken.

air sac luchtzak

Zak die aan de long van een vogel zit.

alcohol poisoning alcoholvergiftiging

Vergiftiging door het drinken van veel alcohol.

allergic reaction allergische reactie

Reactie van het immuunsysteem op een stof waar iemand overgevoelig voor is.

allergy allergie

Overgevoeligheid voor bepaalde stoffen .

alveolus (plural: alveoli) longblaasje

Deel van de longen aan het uiteinde van een luchtpijptakje.

anaphylactic response anafylactische reactie

Ernstige allergische reactie die kan ontstaan wanneer het lichaam vaker in contact komt met een stof waar iemand allergisch voor is.

anorexia nervosa anorexia nervosa

Eetstoornis waarbij mensen extreem weinig eten.

antibody antistof

Eiwit dat ziekteverwekkers onschadelijk maakt.

antigen antigeen

Eiwit op de buitenkant van een cel of van een virus.

antigen A antigeen A

Bloedfactor die voorkomt bij mensen met bloedgroep A en bloedgroep AB.

antigen B antigeen B

Bloedfactor die voorkomt bij mensen met bloedgroep B en bloedgroep AB.

anus anus

Kringspier die de endeldarm afsluit.

aorta aorta

Bloedvat dat zuurstofrijk bloed van het hart naar de organen vervoert.

appendix appendix

Uitstulping aan de onderkant van de blindedarm.

aroma geurstof

Stof die wordt toegevoegd om een voedingsmiddel lekkerder te laten ruiken.

arteriosclerosis slagaderverkalking

Vernauwing van bloedvaten door ophoping van kalk.

artery slagader

Bloedvat waardoor het bloed van het hart wegstroomt.

artificial immunity kunstmatige immuniteit

Immuniteit doordat iemand is ingeënt met een vaccin.

B

best before date THT-datum

Ten minste houdbaar tot-datum; tot en met die datum garandeert een fabrikant de kwaliteit van een product.

bile gal

Verteringssap dat grote vetdruppels in kleinere druppeltjes verdeelt.

bile duct galbuis

Buis waardoor gal van de galblaas naar de twaalfvingerige darm wordt vervoerd.

binge drinking bingedrinking

In korte tijd veel alcohol drinken, waardoor het alcoholgehalte in het bloed snel stijgt tot 0,8 promille of hoger.

binge eating disorder eetbuistoornis

Eetstoornis met eetbuien, waarbij niet wordt gebrakt of een laxermiddel wordt gebruikt.

bladder urineblaas

Tijdelijke opslagplaats van de urine.

blood factor bloedfactor

Antigeen op het celmembran van een rode bloedcel.

blood group bloedgroep

Bloedtype gebaseerd op bloedfactoren.

blood plasma bloedplasma

Deel van het bloed dat bestaat uit water, plasma-eiwitten en opgeloste stoffen.

blood pressure bloeddruk

Druk die op de slagaders staat wanneer het bloed wordt rondgepompt.

blood transfusion bloedtransfusie

Bloed toedienen aan een ander persoon.

body mass index (BMI) Body Mass Index (BMI)

Methode om te meten of je een gezond gewicht hebt.

bowel movement (stool) ontlasting

Het legen van de endeldarm

bronchi bronchiën

Deel van het ademhalingsstelsel waarin de luchtpijp zich vertakt.

building materials bouwstof

Voedingsstof die wordt gebruikt bij de vorming van cellen en weefsels.

bulimia nervosa boulimia nervosa

Eetstoornis met eetbuien, waarna het voedsel wordt uitgebraakt of laxermiddelen worden gebruikt.

C

caecum blindedarm

Orgaan dat onderdeel is van het verteringsstelsel, maar geen eigen functie heeft bij de vertering.

canine hoektand

Tand waarmee stukken van voedsel wordt afgebeten, en die bij de mens iets puntiger is dan een snijtand.

capillary haarvat

Bloedvat waarvan de wand nog maar één cellaag dik is.

carbohydrates koolhydraat

Voedingsstof die vooral dient als brandstof, maar ook als bouwstof en reservestof kan dienen.

carbon monoxide koolstofmonoxide

Reukloos gas dat, wanneer het in je bloed wordt opgenomen, ervoor zorgt dat er minder zuurstof opgenomen kan worden.

cardiac pause hartpauze

Periode waarbij de boezems en de kamers ontspannen zijn.

cardiac septum harttussenwand

Scheiding tussen de linker- en rechterharthelft.

cardiovascular disease hart- en vaatziekten

Verzamelnaam voor ziekten aan hart en bloedvaten.

carnivore vleeseter

Zoogdier dat alleen dieren eet.

CBD CBD

Stof in cannabis die de werking van THC beïnvloedt.

chemical digestion chemische vertering

Vorm van vertering waarbij stoffen worden omgezet in andere stoffen door middel van scheikundige reacties.

chest breathing (thoracic breathing) borstademhaling

Ademhaling waarbij de ribben en het borstbeen bewegen.

cilium (plural: cilia) trilhaar

Organel dat slijm (met stofdeeltjes) van de neus naar de keelholte verplaatst.

circular muscles kringsspieren (in de darmwand)

Spieren in de darmwand die, samen met de lengtespieren, ervoor zorgen dat de voedselbrij wordt voortgeduwd, gekneed en vermengd met verteringssappen.

circulation bloedsomloop

Weg die het bloed door het lichaam aflegt.

circulatory system bloedvatenstelsel

Alle bloedvaten in het lichaam.

clotting bloedstolling

Het stollen van het bloed als het buiten de bloedvaten komt.

cold-blooded koudbloedig

Temperatuur gelijk aan de omgeving hebben.

colouring kleurstof

Stof die wordt toegevoegd om een voedingsmiddel er mooier uit te laten zien.

coronary artery kransslagader

Aftakking van de aorta waardoor bloed richting de hartspier stroomt.

coronary vein kransader

Bloedvat dat bloed wegvoert uit de hartspier.

cutting molar knipkies

Kies van een vleeseter met scherpe randen om het voedsel in stukken te knippen.

D

diaphragm middenrif

Stevig, gespierd vlies dat de romp verdeelt in de borstholte en de buikholte.

dietary fibre voedingsvezel

Onverteerbare stof in plantaardig voedsel die nodig is voor een goede darmwerking.

digestion vertering

Het afbreken van grotere voedingsstoffen tot kleinere verteringsproducten die in het bloed kunnen worden opgenomen.

digestion products verteringsproduct

Voedingsstof die door de darmwand in het bloed kan worden opgenomen.

digestive gland verteringsklier

Klier dat verteringssap aanmaakt.

digestive juices verteringssap

Sap dat voedsel afbreekt in kleinere stukjes.

digestive system verteringsstelsel

Alle delen van het lichaam die betrokken zijn bij de vertering van voedsel.

double circulatory system dubbele bloedsomloop

Bloedsomloop waarbij het bloed per omloop twee keer door het hart stroomt.

duodenum twaalfvingerige darm

Orgaan dat voedselbrij vermengt met gal en alvelessap.

E**E number** E-nummer

code die een additief krijgt als het geen gevaar oplevert voor de gezondheid.

eating disorder eetstoornis

stoornis waarbij iemand constant in het hoofd bezig is met eten en de invloed daarvan op het lichaam.

emulsification emulgeren

Het verdelen van grote vetdruppels in kleinere vetdruppels.

enzyme enzym

Stof die een scheikundig proces versnelt.

epiglottis strotklepje

Klepje dat de luchtpijp afsluit als je voedsel inslikt.

estimate estimate

Engels woord voor schatting en de betekenis van de letter 'e' op een verpakking.

exogenous substance, foreign substance

lichaamsvreemde stof

Stof die niet in je lichaam thuishoort.

F**fats** vet

Voedingsstof die vooral dient als brandstof, maar ook als bouwstof en reservestof kan dienen.

fibrinogen fibrinogeen

Plasma-eiwit dat een functie vervult bij de bloedstolling.

flavouring smaakstof

Stof die wordt toegevoegd om een voedingsmiddel lekkerder te laten smaken.

flexitarian flexitariër

Iemand die ervoor kiest om af en toe vlees te eten.

food poisoning voedselvergiftiging

Afweerreactie die ontstaat door het eten van voedsel dat is besmet met giftige stoffen.

foodstuff voedingsmiddel

Product dat men eet of drinkt.

fuel (as a nutrient) brandstof (als voedingsstof)

Voedingsstof die energie levert.

fuel (for respiration) brandstof (voor verbranding)

Stof die verbrandt.

G**gall bladder** galblaas

Orgaan dat dient als tijdelijke opslagplaats voor gal.

gas exchange gaswisseling

De opname en afgifte van zuurstof en koolstofdioxide via de longblaasjes.

gastric gland maagsapklier

Klier in de maagwand die maagsap produceert.

gastric juices maagsap

Verteringssap dat bestaat uit water, zoutzuur en een enzym.

gill kieuw

Orgaan waarmee vissen zuurstof opnemen vanuit het water.

glucose glucose

Stof die veel energie bevat die wordt gebruikt om andere stoffen te maken.

H**habituation** gewenning

Steeds meer nodig hebben van een (verslavend) middel om hetzelfde effect te ervaren.

haemoglobin hemoglobine

Eiwit dat zuurstof bindt en weer loslaat.

hangover kater

Hoofdpijn, dorst en/of misselijkheid door vochtverlies en door de giftige stoffen die ontstaan bij de afbraak van alcohol.

hay fever hooikoorts

Allergie voor stuifmeelkorrels.

heart attack (myocardial infarction) hartinfarct

Verstopping van een kransslagader waardoor een deel van de hartspier geen zuurstof en voedingsstoffen meer krijgt.

heart valve hartklep

Klep tussen een boezem en een kamer.

heartbeat hartslag

Samentrekken van de boezems, gevolgd door het samentrekken van de kamers, gevolgd door een hartpauze.

herbivore planteneter

Zoogdier dat alleen planten eet.

hibernation winterslaap

Lange periode waarbij de lichaamstemperatuur daalt en de stofwisseling vertraagt.

high high
Effect van cannabis waarbij je energiek en vrolijk wordt.

I
immune immuun
Niet ziek worden, omdat witte bloedcellen vrijwel onmiddellijk antistof kunnen maken voor een ziekteverwekker waarmee je al eens bent besmet.

immune system (defence system)
immuunsysteem (afweersysteem)
Systeem in het lichaam dat ziekteverwekkers bestrijdt.

incisor snijtand
Tand waarmee stukken van voedsel wordt afgebeten, en die bij de mens minder puntig is dan een hoektand.

infection infectie
Binnendringen van ziekteverwekkers in het lichaam.

inferior vena cava onderste holle ader
Ader waardoor het zuurstofarme bloed van de romp en de benen naar het hart stroomt.

ingredient ingrediënt
Grondstof in een product.

insulation isolatie
(Vet)laag die warmbloedige dieren warm houdt.

intestinal fold darmplooi
Plooi in de dunne darm.

intestinal gland darmsapklier
Klier in de wand van de dunne darm die darmsap produceert.

intestinal juice darmsap
Verteringssap met enzymen dat de vertering van eiwitten, koolhydraten en vetten afmaakt.

intestinal tract darmkanaal
Kanaal van de mond tot de anus.

intestinal villus darmvlok
Uitstulping op een darmplooi.

K
kidney nier
Orgaan dat afvalstoffen uit het bloed haalt.

kilocalorie kilocalorie
Eenheid voor de energie in voedsel, afgekort als kcal.

kilojoule kilojoule
Eenheid voor de energie in voedsel, afgekort als kJ.

knobbly molar knobbelkies
Kies van een alleseter met een knobbelig oppervlak om het voedsel fijn te malen.

L
large intestine dikke darm
Orgaan waar al het water uit de brij van onverteerde voedselresten wordt opgenomen.

left atrium linkerboezem
Deel van het hart waar de longaders in uitmonden.

left ventricle linkerkamer
Deel van het hart dat het bloed via de aorta naar alle organen van het lichaam pompt.

liver lever orgaan
Dat gal produceert.

longitudinal muscles lengtespieren (in de darmwand)
Spieren in de darmwand die, samen met de kringspieren, ervoor zorgen dat de voedselbrij wordt voortgeduwd, gekneet en vermengd met verteringssappen.

lymph lymfe
Vloeistof in de lymfevaten.

lymph node lymfeknoop
Klier die lymfe zuivert van onder andere ziekteverwekkers.

lymphatic system lymfevatenstelsel
Alle lymfevaten in het lichaam.

lymphatic vessel lymfevat
Vat waarin weefselvloeistof terechtkomt die niet is opgenomen door een haarvat.

M
malnutrition (malnourishment) ondervoeding
Te weinig energie of voedingsstoffen binnenkrijgen.

meat substitute vleesvervanger
Voedselproduct dat op vlees lijkt in uiterlijk, smaak, samenstelling en voedingswaarde.

mechanical digestion mechanische vertering
Voedsel in kleine stukjes kauwen.

metabolism stofwisseling
Het omzetten van stoffen in andere stoffen.

migration trek
Wegtrekken van een groep dieren naar warmere gebieden.

minerals mineraal
Voedingsstof die dient als bouwstof en beschermende stof.

mitochondrion (plural: mitochondria) mitochondrium
Celorganel dat glucose afbreekt.

molar kies
Tand waarmee voedsel wordt fijngemalen.

N**nasal lining** neusslijmvlies

Slijmvlies in de neus dat uit slijmproducerende cellen bestaat.

natural immunity natuurlijke immuniteit

immuniteit doordat iemand de ziekte zelf heeft meegemaakt.

nicotine nicotine

Stof in sigaretten die ervoor zorgt dat mensen verslaafd raken aan roken.

nutrient voedingsstof

Stof die je lichaam nodig heeft voor energie, groei of herstel.

nutritional value voedingswaarde

Hoeveelheid energie, vetten, eiwitten, koolhydraten en zout die een product bevat.

O**obesity** obesitas

Ernstig overgewicht.

oesophagus slokdarm

Orgaan dat voedsel verplaatst van de keelholte naar de maag.

omnivore alleseter

Zoogdier dat planten en dieren eet.

overweight overgewicht

Te hoog lichaamsgewicht, waarbij er te veel vet in het lichaam is opgeslagen.

P**pancreas** alvleesklier

Klier die alvelessap produceert.

pancreatic juice alvelessap

Verteringssap met verschillende enzymen die zorgen voor de vertering van eiwitten, koolhydraten en vetten.

passive smoking passief roken (meeroken)

Inademen van rook van brandende sigaretten of die door een ander is uitgeblazen.

pasteurization pasteuriseren

Verhitten tot 72 °C, waardoor de meeste bacteriën en schimmels doodgaan.

peristalsis (peristaltic movements)

darmperistaltiek (peristaltische beweging)

Het afwisselend samentrekken en ontspannen van kringspieren en lengtespieren in de wand van het darmkanaal.

physically dependent lichamelijk afhankelijk

verslaving aan een stof, waarbij je lichaam protesteert als je de stof niet binnenkrijgt.

platelet bloedplaatje

Deel van een uiteengevallen cel dat een functie vervult bij bloedstolling.

portal vein poortader

Bloedvat dat bloed van de darmwand naar de lever vervoert.

preservation conserveren

Voedsel behandelen zodat het niet bederft.

preservative conserveermiddel

Stof die de leefomgeving voor bacteriën en schimmels ongunstig maakt.

product information productinformatie

Informatie over de inhoud van een voedingsmiddel.

production code (batch code) productiecode (partijcode)

Code die weergeeft waar en wanneer een product gemaakt is.

protective substance beschermende stof

Voedingsstof die ervoor zorgt dat je niet ziek wordt.

proteins eiwit

Voedingsstof die voornamelijk dient als bouwstof, maar ook als brandstof en reservestof kan dienen.

psychologically dependent geestelijk afhankelijk

Verlangen naar een (verslavend) middel.

pulmonary artery longslagader

Bloedvat dat zuurstofarm bloed van het hart naar de longen vervoert.

pulmonary capillary longhaarvat

Klein bloedvaatje rondom een longblaasje.

pulmonary circulation kleine bloedsomloop

Bloedsomloop waarbij het bloed van het hart naar de longen en weer terug naar het hart stroomt.

pulmonary vein longader

Bloedvat dat zuurstofrijk bloed van de longen naar het hart vervoert.

pyloric sphincter maagportier

Kringspier die de uitgang van de maag af kan sluiten.

R**rectum** endeldarm

Orgaan waar onverteerde voedselresten tijdelijk worden opgeslagen.

red blood cell rode bloedcel bloedcel

Zonder celkern en met hemoglobine.

renal artery nierslagader

Slagader waardoor zuurstofrijk bloed naar een nier stroomt.

renal cortex nierschors

Deel van de nier dat urine vormt.

renal medulla niermerg

Deel van de nier dat urine vormt.

renal pelvis nierbekken

Deel van de nier waarin urine wordt verzameld.

renal vein nierader

Ader waardoor gezuiverd bloed weg van een nier stroomt.

reserves reservestof

Voedingsstof die wordt opgeslagen in bepaalde delen van het lichaam.

respiration verbranding

De afbraak van glucose in cellen.

respiratory muscle ademhalingsspier

Spier die nodig is om adem te halen.

ridged molar plooi kies

Kies van een planteneter met harde richels om voedsel fijn te malen.

right atrium rechterboezem

Deel van het hart waar de holle aders en de kransaders uitmonden.

right ventricle rechterkamer

Deel van het hart dat het bloed in de longslagaders pompt.

S**saliva** speeksel

Verteringsap dat bestaat uit water, slijm en een enzym.

salmonella bacterium salmonellabacterie

Bacterie die giftige afvalstoffen produceert.

semilunar valve halvemaa nvormige klep

Klep aan het begin van de longslagader of de aorta.

small intestine dunne darm

Orgaan waar via de darmwand verteringsproducten worden opgenomen in het bloed.

smog smog

Luchtvervuiling die vooral bestaat uit fijnstof.

spiracle stigma

Opening waardoor lucht de trachee instroomt.

sterilization steriliseren

Verhitten tot 130-140 °C, waardoor alle bacteriën en schimmels doodgaan.

stomach maag

Orgaan dat voedsel tijdelijk opslaat.

stoned stoned

Effect van cannabis waarbij je lui en ontspannen wordt.

storage instructions bewaarvoorschrift

Beschrijving waarin staat hoe je een product moet bewaren.

superior vena cava bovenste holle ader

Ader waardoor het zuurstofarme bloed van het hoofd en de armen naar het hart stroomt.

systemic circulation grote bloedsomloop

Bloedsomloop waarbij het bloed van het hart naar de rest van het lichaam (behalve de longen) en weer terug naar het hart stroomt.

T**tar** teer

Stof in tabaksrook die schadelijk is voor de longen.

THC THC

Stof in cannabis waar je stoned of high van wordt.

tissue fluid weefselvloeistof

Vloeistof die zich tussen de cellen van de organen bevindt.

tracheae tracheeën

Sterk vertakte ademhalingsbuisjes in het lichaam van een insect.

U**underweight** ondergewicht

Te laag lichaamsgewicht.

ureter urineleider

Buis die urine afvoert van een nier naar de urineblaas.

urethra urinebuis

Buis die urine afvoert uit het lichaam.

urine urine

Verzameling van stoffen die door de nieren zijn verwijderd uit het bloed.

use by date TGT-datum

Te gebruiken tot-datum; dit is de laatste dag waarop je een product nog veilig kunt eten of drinken.

uvula huig

Klepje dat de neusholte afsluit als je voedsel inslikt.

V**vaccination** vaccinatie

Inenting waarbij je een vaccin krijgt ingespoten.

vaccination coverage vaccinatiegraad

Percentage mensen dat gevaccineerd moet worden om de bevolking als geheel te beschermen tegen een ziekte.

vaccine vaccin

Middel dat een dode of verzwakte ziekteverwekker bevat.

valve klep

Soort vlies dat ervoor zorgt dat het bloed maar in één richting kan stromen.

vegan veganist

Iemand die geen dierlijke producten eet.

vegetarian vegetariër

Iemand die geen vlees eet.

vein ader

Bloedvat waardoor het bloed naar het hart toestroomt.

ventilation ventilatie

Het vervangen van 'oude' lucht met verse lucht.

vitamins vitamine

Voedingsstof die dient als bouwstof en beschermende stof.

W**warm-blooded** warmbloedig

Constance lichaamstemperatuur hebben.

water water

Voedingsstof die dient als bouwstof en die nodig is voor het vervoer van stoffen in je lichaam.

white blood cell witte bloedcel

Bloedcel met een celkern en zonder vaste vorm.

windpipe (trachea) luchtpijp

Holle buis die aansluit op de onderkant van het strottenhoofd.

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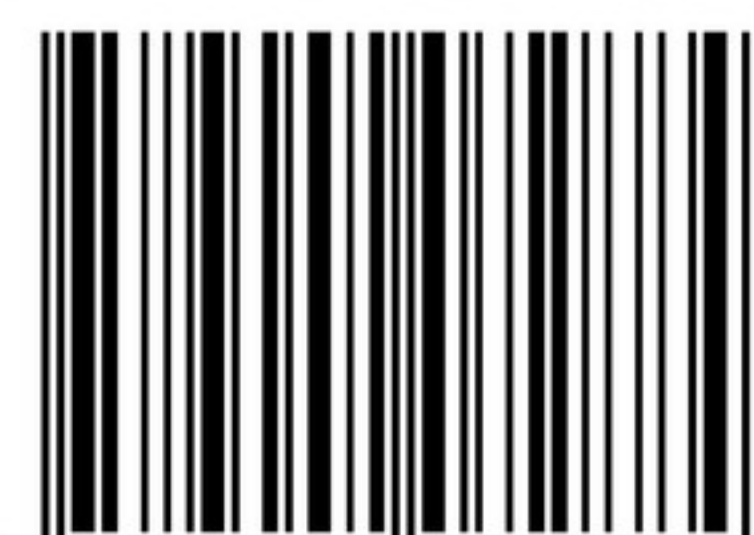
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